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U. S. DEPARTMENT OF AGRICULTURE.

---

# ANNUAL REPORT

OF THE

# OFFICE OF EXPERIMENT STATIONS

FOR THE

## YEAR ENDED JUNE 30, 1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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### NUTRITION INVESTIGATIONS.

W. O. Atwater, Ph. D., Chief of nutrition investigations, Middletown, Conn.
C. D. Woods, B. S., Special agent at Orono, Me.
F. G. Benedict, Ph. D., Physiological chemist.
R. D. Milner, Ph. D., Assistant.

### IRRIGATION AND DRAINAGE INVESTIGATIONS.

Elwood Mead, M. S., C. E., D. E., Chief of irrigation and drainage investigations.
R. P. Teele, M. A., Editorial assistant.
C. G. Elliott, C. E., Engineer in charge of drainage investigations.
C. E. Tait, B. S., Assistant in charge of central district.
Samuel Fortier, M. E., Agent and expert in charge of Pacific district.
W. B. Gregory, C. E., Agent and expert in charge of rice investigations in Louisiana and Texas.

# LETTER OF TRANSMITTAL.

Office of Experiment Stations,
*Washington, D. C., February 25, 1905.*

Sir: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, the publication of which is authorized by joint resolution of the Fifty-eighth Congress, second session. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1904, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

> The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

Reports are also included on the experiment stations in Alaska, Hawaii, and Porto Rico, which are provided for in the appropriation act aforesaid and are directly managed by this Department.

Very respectfully,

A. C. True, *Director.*

Hon. James Wilson,
*Secretary of Agriculture.*

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# ANNUAL REPORT OF OFFICE OF EXPERIMENT STATIONS JUNE 30, 1904.

## SUMMARY.

By A. C. True and Dick J. Crosby.

### STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories, and, under special appropriation acts, in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the act of 1887 during 1904 was $1,508,820.25, of which $719,999.67 was received from the National Government and the remainder, $788,820.58, from State governments, individuals, and communities, fees for analyses of fertilizers, sales of farm products, and miscellaneous sources. In addition to this, the Office of Experiment Stations had an appropriation of $175,000 for the past fiscal year, including $15,000 for the Alaska experiment stations, $15,000 for the Hawaii Experiment Station, $15,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, $65,000 for irrigation investigations, and $5,000 for farmers' institutes. The total value of additions to the equipment of the stations in 1904 is estimated to be $293,451.69.

### DISSEMINATION OF INFORMATION.

The activity of the stations in disseminating the results of their investigations continues unabated. Of the 795 persons employed in station work last year, 414 did more or less teaching in the colleges with which the stations are connected, and 363 assisted in farmers' institutes, contributing a total of 2,131 days to this work. In this way the results of investigations in agriculture were brought directly to the attention of about 10,000 students in agricultural colleges and probably five or six times as many attendants at farmers' institutes.

A much larger number of farmers has been reached and a wider influence has been extended by means of the publications of the stations. These publications during the past year aggregated 393 annual reports and bulletins, and a total of more than 6,400,000 copies of them was distributed to over 685,000 addresses on the regular mailing lists. The stations also published and distributed over 322,000 copies of circulars, besides numerous leaflets, press bulletins, and other special publications. Many of them report rapidly growing mailing lists and correspondence, and in some cases the demands of this nature have been more than the stations could meet. Considering their limited resources, these institutions are accomplishing a large amount of useful work and giving wide publicity to the results attained.

## PROGRESS OF THE STATIONS.

The practical value and general importance of experiment station work become more apparent as the results of experiments and of the educational movement inaugurated and fostered by these institutions accumulate. In no particular line of work are the possibilities greater than in the field of agronomy—the basis of all agricultural production. The total annual production and value of the different field crops grown in this country are enormous. According to the Statistician of this Department the average yields of the five crop years last past for the entire country amount to approximately 2,180,000,000 bushels of corn, 625,000,000 bushels of wheat, 843,000,000 bushels of oats, 115,000,000 bushels of barley, and 29,000,000 bushels of rye. These figures will probably quite closely approximate average crops of the cereals named for the present time. The production for the year 1904 represents a total value of over $1,950,000,000 created on a little over 171,000,000 acres. The value in dollars of a movement increasing the production per acre by only one bushel, or increasing the value per bushel by only a few cents, can readily be calculated.

The influence of experiment station work in this line is manifesting itself in different ways. The work itself is becoming more effective and more productive of immediate results, as the stations are attracting the attention and arousing the interest of the farming population and the business interests alike. Cooperative experiments are increasing in number and extending in scope, and educational campaigns are now conducted which some years ago would not have met with half the success, if they had been possible at all.

Great progress has been made in recent years in popularizing improved methods of culture; plant, seed, and variety selection; grain judging and grading, and other phases of production and marketing, and the efforts put forth in each particular line are bearing good fruit.

In the earlier work of the stations variety tests with the different field crops were begun on a more or less extensive scale, and as the results accumulated from year to year the least promising sorts were discarded. After this process of variety selection had begun to show progress, attention was turned toward the improvement of the particular varieties themselves. Systematic studies and methods in variety improvement by means of plant breeding and selection are now followed by over one-half of the stations of the country, and while at some of these institutions the work in this line is still too new to have borne definite results, others during the past five or ten years have made marked progress. As a notable instance of this kind, the corn-improvement work carried on at different stations may be cited. Aside from the improvement in yield the stations have realized the possibility and desirability of improving corn in composition. Results of some very interesting and important work have been reported by the Illinois Station. The purposes in the production of corn were considered and the conclusion reached that, for feeding, the value of the grain would be increased by a higher protein content, but for the manufacture of oil and allied substances, by a higher oil content. Work along the lines of increasing the protein and oil content of the kernel was taken up and a system of corn breeding has been inaugurated, which is resulting in not only improving standard varieties, but in originating new and improved strains within them. The station has obtained pedigreed corn with 15 per cent of protein in the one line of work, and with 7 per cent of oil in the other; while corn low in these constituents contains only about 10 per cent of protein and about 2½ per cent of oil. The results, in general, have shown that the content of either protein, oil, or starch may be increased by systematic breeding and selection. In addition to the work described, the station has devised a method of determining approximately the chemical composition of the corn kernel by a simple mechanical examination, capable of being made with a pocket knife, and has thus placed the work of corn selection and breeding for a higher oil and protein content within the reach of every farmer. The Kansas Station has called attention to the deficiency of protein in commercial seed corn, and for a number of years has worked on the increase of protein in corn by means of crossing varieties and seed selection. The same line of work has been followed by the North Dakota Station, and at both these institutions strains richer in protein have been originated. The North Dakota Station has established a plant-breeding nursery for field crops, and in 1903 something over 50,000 plants of different cereals and forage crops were matured.

Experiments in the methods of cultivating corn have been conducted by most of the stations of the country, and this work more than any other has shown the advantages of frequent and shallow stirring of the soil in the cornfield.

The Minnesota Station some years ago originated a new variety of corn, and after testing the same for several years and satisfying itself of its merits, began the systematic distribution of the same, with the result that at present it is grown as one of the standard varieties throughout the southern part of Minnesota, the region for which it was intended. The distinguishing character of this new variety was an increase in yielding capacity, and it is estimated from the reports received that it yields from 4 to 5 bushels more per acre than the varieties for which it was substituted. As another evidence of its value the fact may be cited that the South Dakota Experiment Station is now distributing the variety among the farmers of that State.

In the matter of impressing upon the farmer the importance of seed-corn selection and the value of good seed corn, the stations of the corn belt have of recent years been most active and successful. Bulletins on the subject have been published and sent over the respective States, and other methods of disseminating information have been employed. A unique method of bringing the subject before the people was followed by the Iowa Station, assisted in its efforts by some of the railroads crossing the State, and supported by the agricultural press and agricultural associations. A special train known as the "seed-corn special" was run for the purpose of giving instruction in selecting, testing, and planting seed corn. In eight days this train covered over 1,300 miles in 37 of the 99 counties of the State, and 150 short lectures were delivered by the agronomist of the station to 17,600 hearers. General interest was awakened; the farmer and the business man alike supported and approved of the movement, and the information given out was carried by those who attended the lectures, and also largely by the press, to everyone interested in farming within the State. Similar work has been done by the Nebraska Station.

As another line of work promoted by these same stations may be mentioned the judging of corn in the ear according to a scale of points, or score card. A number of years ago this was unknown. The idea was perfected by the stations, in some instances with the cooperation of seed-growing interests. The different score cards in use have many points in similarity, but an effort has been made to adapt them to the different regions in which they are applied.

Considerable attention has also been given to the improvement of wheat in both yield and quality. New varieties of wheat originated by the Minnesota Station have spread during the last few years throughout the State of Minnesota, and have also found their way to neighboring States. They prove of value for the northwestern wheat section, and are now successfully grown on about half a million acres, and are estimated to yield from 1 to 2 bushels more per acre than the varieties they are replacing. In quality these new varieties rank with the best Minnesota hard wheat.

The Nebraska and South Dakota stations in the last three or four years have been largely instrumental in the testing and distribution of macaroni wheats introduced by this Department. The Nebraska Station has also directed its efforts toward the adaptation and improvement of winter wheat, and this work has added considerably to the increase in acreage of the crop within the State and to the gradual movement northward of its limit of culture. It has also made considerable progress in breeding wheats of higher protein content than those commonly grown.

Along with other stations, the Tennessee Station has shown that the yield and quality of cereal crops, including winter oats, winter barley, and winter rye, can be improved by selection, and that crops of winter cereals are of the greatest benefit to the soil, in addition to being directly profitable under Tennessee conditions.

A vast amount of work has been done by the stations during the past ten years in the introduction, testing, and improvement of forage crops, and the value of the results can not be overestimated. The stations in the semiarid regions, where this kind of work was mostly needed, have been most prominent in the movement. The Kansas, Oklahoma, and Texas stations have tested numerous varieties of nonsaccharine sorghums, the principal one among them being Kafir corn, which has become a standard forage crop in many parts of the dry regions. The work with the cowpea has also been of incalculable benefit, especially in the Southern States, where the crop grows most successfully. The Arkansas Experiment Station has been a leader in this line, and has pointed out the value of the cowpea as a land renovator and a rotation and forage crop. Breeding experiments have also been made and a number of promising selections and crosses have resulted. Timothy breeding is being followed at the Minnesota, West Virginia, and New York Cornell stations. At the last mentioned institution seed was secured from different parts of this country and also from foreign countries. Seedling plants were grown in the greenhouse, and at present about 12,000 seedling plants are grown on timothy breeding plats. The plants were planted singly and the bunches produced from them only one year after transplanting already show great variations.

The stations in the cotton-growing States have disseminated much useful information regarding the culture of cotton and the use of fertilizers in this connection, and have also worked along the line of improving varieties in yield, earliness, and staple by means of crossing and selection. The breeding of early varieties has recently aroused renewed interest on account of the importance of earliness in reducing the ravages of the boll weevil, the late-maturing cottons being much more subject to its attacks.

Another striking illustration of the value of experiment station work through a series of years may be found in the culture and variety tests with sugar beets. The progress made in the past ten or twelve years in the culture of this crop has made beet-sugar production a permanent agricultural industry in this country, and a very important factor in pointing out the possibilities and in determining the sections of the country in which the industry could be profitably established has been the work with the sugar beet at the different experiment stations.

Along the different lines of field-crop breeding at the Minnesota Station the work with flax has reached the stage where it can be made directly available and beneficial to the flax growers of the State. This station has at present about 1,200 bushels of pedigreed flaxseed of a new variety, known as the "Premost" flax, ready for distribution to farmers and seed growers who will guarantee to grow for seed the several bushels of seed allotted to them. This has been the policy of the station in distributing its new varieties, and the plan has proved most successful. The distinguishing feature of the new variety of flax is a much heavier yield of seed than is obtained from the common varieties now generally grown.

## NEEDS OF THE STATIONS.

The rapid advance of agricultural research in this country and the large application of some of the results of the investigations of the stations to the betterment of our agricultural practice have made the public mind so favorable to the extension of the funds and work of the stations that there is little difficulty in securing the money needed to develop their work. The great difficulty at present is to form in the public mind an accurate conception of the proper functions of the stations and prevent the hampering of their researches by the imposition of burdensome duties which tend to divert them from their legitimate field and weaken their efforts to gain new knowledge for the benefit of agriculture. As long as this is true it will be necessary to keep problems relating to the organization of the stations prominently in view. This necessity is evidently being more clearly recognized by the station directors and workers, so that we find them discussing these problems very earnestly both in their local councils and in the Association of American Agricultural Colleges and Experiment Stations. It is very important that this discussion should engage the attention of a wider circle and include not only the boards of control of the stations, but also the State officers and legislators, who are called upon to provide additional funds for their use, as well as the great body of intelligent farmers, who are looking to the stations for practical advice and assistance.

Unless the leaders of public opinion on agricultural affairs can be brought to recognize the proper functions and the desirable limitations of institutions devoted to agricultural research, it will be impracticable to secure for the stations that freedom of investigation which is essential to the best and most enduring results. It is for this reason that we insist so strongly that the stations should everywhere be organized primarily and chiefly as research institutions, and that they should be relieved of duties which do not relate directly to research or which interfere with its orderly and continuous progress. We shall have gained a great advantage when the public clearly recognizes the stations as research institutions and does not expect them to turn aside from this work. While there has been advance along this line, we have not yet reached a point where the functions of the stations are generally differentiated in the public mind from those of the agricultural colleges, farmers' institutes, inspection bureaus, and other agencies for agricultural advancement.

We urge, therefore, that the station managers and workers shall themselves seek to simplify the organization and work of the stations and make more strenuous efforts to slough off duties which should be performed by other organizations. This does not mean that the stations shall be separated from the agricultural colleges, or that they shall not maintain vital relations with the farmers' institutes and other agencies for the education of our farmers. It does, however, involve an organization of the stations under which the investigator shall be so situated that he can plan and carry out thorough investigations as his chief business, with which nothing else will be allowed to interfere. This means that the governing boards and general college officers shall definitely arrange with the station workers that the work of research shall be steadily pursued and that means and facilities shall be provided to make the work effective. Whatever teaching or other duties station workers may properly be called upon to perform shall distinctly have second place, shall be very carefully limited, and shall only be performed when the requirements of the researches in progress have been fully met. When students increase and demands for the services of station workers outside their laboratories multiply, the authorities should not curtail the time of station workers devoted to research, but should turn away students and turn a deaf ear to outside appeals for help rather than weaken the efficiency of the stations. We believe that the time has come when this issue should be squarely met, because our examination of the work of the stations during the past two years has convinced us that while there is a general improvement of the status of the stations, there are still many places where whatever the theoretical arrangement regarding the time to be devoted to teaching, farmers' institutes, and other extraneous duties, the members of the station staff are actually hampered in the conduct of their researches by the conditions under which they are working.

We urge, therefore, that attention be given by station managers to the correction of this evil, and we believe that it may be largely remedied by a simplification of the station organization. By that we mean that in many more cases than at present the station should have the entire time of men on its staff and that in every case a definite and binding arrangement shall be made with the station worker by which he shall be compelled to make regular and orderly progress in research and shall be put under conditions which will be favorable to the seasonable accomplishment of the research work assigned him. There are now too many members of station staffs who are giving fragments of time to station work and absorbing portions of station funds, which, though individually small, in the aggregate make a considerable amount. It would be better in many cases to drop these men from the station staffs, at least until the station resources are considerably augmented. The division of the station funds among too many departments is still a cause of general weakness in the operations of a number of our stations.

This plan also involves the separation of the organization and management of farmers' institutes, and of the preparation of compiled bulletins and other forms of college extension work from the station, and provision for the carrying on of such work in other departments of the agricultural college.

It is also very desirable that the work of the stations shall be more fully organized with reference to the permanent character of these research institutions for the benefit of agriculture. Many of the more superficial problems of our agriculture have been solved, while many of the more fundamental problems have received comparatively little attention. This is so, in part at least, because the stations have had thus far in too great measure an unstable policy and a rapidly shifting personnel. If they are ever to do satisfactory work on the larger problems they must settle down to enterprises planned to continue for long periods and to be kept as far as practicable in the hands of the same men. For example, it has been pointed out that the stations are changing from variety testing to the breeding of improved varieties of plants. While important practical results have already come from this change, there will be many cases in which it will take years to produce and fix new and better types of plants. In the feeding of animals the superficial experiments with different kinds of feeding stuffs have largely run their course, but there remain the fundamental problems relating to the laws of animal nutrition, about which our present knowledge is very imperfect. The study of these greater problems involves expensive apparatus and the long training of experts.

The simplification of the station business in the direction of more exclusive attention to research and the employment of more men wholly or chiefly as investigators will lay a foundation for taking up the greater problems of agriculture by providing a larger body of trained and experienced investigators, so that with the coming of greater financial resources the stations will be able to do with relatively little waste of public money the greater tasks on the results of which the permanent prosperity of our agriculture will rest.

We therefore plead once more that the managers of stations should give greater attention to the human elements involved in the organization of these institutions, and see to it that efficient workers with ample time and good facilities are more largely put in charge of agricultural investigations in this country.

## STATISTICS OF THE LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1904 is estimated to be $72,540,588.11. The income of these institutions in 1904, exclusive of the funds received from the United States for agricultural experiment stations, was $11,498,341.35. The value of the additions to their permanent endowment and equipment in 1904 is estimated to be $3,221,973.53. The number of persons in the faculty of the colleges of agriculture and the mechanic arts was 2,740, and in other departments 1,575, making a grand total of 4,315. The number of students in 1904 was 56,226, of whom 4,436 were in four-year courses in agriculture, and 6,962 in shorter courses in agriculture, dairying, horticulture, and veterinary science. The graduates in 1904 were 4,822, and since the organization of these institutions, 57,909.

## PROGRESS IN AGRICULTURAL EDUCATION.

A very striking illustration of the general advance of agricultural education in this country during the past decade was presented in the elaborate exhibit of the agricultural colleges and experiment stations at the Louisiana Purchase Exposition at St. Louis as compared with the exhibit which the same institutions were able to make at the Columbian Exposition at Chicago in 1893. It was thus made evident that during the period between these expositions the whole programme of study at the agricultural colleges has been extensively revised and improved in accordance with the development of a real science of agriculture, based on the results of the investigations of the experiment stations and the Department of Agriculture. The appliances, apparatus, and illustrative material for the courses in the different branches of agriculture have also been so far extended and improved that it was possible to make an essentially new showing of equipment for instruction in these lines at the St. Louis Exposition. For the first time in the history of the agricultural colleges they were able to put into concrete form a systematic representation of their scheme of education which was worthy to be put alongside of the exhibits of the long-established branches of learning in the educational building of a great international exposition.

The past fiscal year has also been notable for encouraging and substantial progress in all phases of agricultural education throughout the United States. Several States which have heretofore given but little aid to their agricultural colleges have this year provided more or less liberal funds for additional buildings or for maintenance. In this way the total income of the land-grant colleges has been increased by two and a quarter million dollars, and the value of the additions to their permanent endowment and equipment by over half a million dollars. The buildings erected recently have been more substantial than those of earlier days and they are much better adapted to the peculiar needs of the agricultural practicum, which is rapidly becoming a most valuable feature of instruction in agriculture. Much attention has been given to the improvement of college courses in agriculture and to the further adaptation of these courses to the needs of special industries. Graduate instruction in agriculture has also received a good share of attention, not only in the colleges themselves, but also in the Association of American Agricultural Colleges and Experiment Stations, which is endeavoring, through its committee on graduate study, to arrange for biennial sessions of the Graduate School of Agriculture.

Greater interest than ever before has been manifested in what may be called the extension work of the colleges—farmers' institutes; short winter courses for farmers; correspondence courses; summer schools for the preparation of teachers of elementary agriculture, nature study, and school gardening; the organization of experimental clubs among country boys and girls; the preparation of courses in agriculture for rural schools; the preparation and distribution of literature intended to promote these enterprises; the giving of itinerant lectures, and, in short, everything which makes for more wholesome rural conditions. Several of the colleges now have definitely organized departments for carrying on extension work, while others have detailed to this service members of their staff who have other duties.

Progress has been made during the year along lines of secondary and elementary education in agriculture and in the training of teachers for this work. New schools have been established. The older schools have been better supervised and their courses of study improved. More attention than formerly has been given to providing agricultural and horticultural courses for women. Efforts to introduce agricultural instruction into the common schools have been attended with such encouraging results as to greatly stimulate discussion and experiment along this line. It is estimated from partial returns that fully 12,000 pupils received instruction in agriculture in the common schools of North Carolina last year. The programme of the last convention of the Association of American Agricultural Colleges and Experiment Stations gave a prominent place to the subject of elementary instruction in agriculture, and the committee of the association on methods of teaching agriculture presented a report on this subject. The National Educational Association has a standing committee composed of educators of national repute who are studying the problem of introducing more generally nature study, school gardening, and other agricultural instruction into the public schools. School officers and legislators in a number of States and Territories are now engaged in preparing courses of study and legislation providing for agriculture in the common schools.

It is clearly apparent that the cause of agricultural education is being considered in more of its phases and by more prominent men than ever before. The outlook is therefore more hopeful for steady and wholesome progress in the direction of relating education more closely to the needs of the people.

## THE FARMERS' INSTITUTES.

Statistics of the farmers' institutes in the United States, and other information regarding their organization and progress during the past year, have been collected by the farmers' institute specialist of this Office, and are included in a detailed report given on page 617. According to this report 3,306 institutes were held during the year in 46 States and Territories. The total attendance at these institutes was over 841,000. The appropriations for institute purposes amounted to $210,000, but the amount actually available for institutes was much larger than this, for the salaries of the directors in 26 States are not included in this amount, nor, except in a few States, is the cost of printing the 329,000 reports of institute proceedings which were published and distributed last year. The institutes were addressed by 953 lecturers, employed by the State directors. Of this number 361 are members of the faculties of the agricultural colleges or of the staffs of experiment stations, who contributed during the year 2,131 days of their time to giving institute instruction. Twenty-eight States reported also a total of 3,331 local speakers engaged in institute work, so that in all there were considerably more than 4,000 persons who gave instruction at the institutes during the year.

The principal needs of the institutes are for better organization, more liberal financial support, and a larger number of efficient workers. The form of organization most approved is that of a strong, permanent local organization in every institute district, with fully and clearly defined duties and powers, the whole system to be subject to the oversight and limited control of a central State authority. As regards funds, only a few of the States provide liberally for the institutes, while eight States and Territories make no appropriation whatever for this purpose. The corps of institute workers is being augmented slowly by trained men from the agricultural colleges and experiment stations, but the supply of lecturers acquainted with both the science and the art of agriculture is still far from adequate. A few of the colleges are endeavoring to improve conditions in this respect by offering short normal courses for institute workers.

The ninth annual convention of the American Association of Farmers' Institute Workers was held at St. Louis, Mo., October 18–20, 1904, and was attended by 100 delegates from 25 States and Territories, the District of Columbia, and three provinces of the Dominion of Canada. The proceedings of this convention have been published as Bulletin No. 154 of this Office, and a brief account of the meeting is given on page 618 of this report.

The work of this Office in relation to farmers' institutes has been continued. The duties of the farmers' institute specialist during the year have been those of organizing the work of the office, of securing information as to the conditions of the institute work in the United States and in foreign countries, and of rendering assistance to the several State directors and institute lecturers through correspondence, personal visits, and the sending out of agricultural literature.

Complete lists of institute lecturers were published and sent to all of the directors of the agricultural experiment stations, with the request that they select from it and add to their mailing list the names of such persons as are not already receiving their publications. This request was quite generally complied with, and numerous expressions of appreciation have come from the lecturers to whom the bulletins have been sent. A similar request was made to the Division of Publications of this Department with equally satisfactory results.

Arrangements have been completed with a number of scientific experts for the preparation of sets of photographs from which to prepare lantern slides illustrative of important agricultural subjects. Each set of photographs is to be accompanied by a syllabus containing explanations of each slide and provided with full references to the literature of the subject. A few sets of slides have now been prepared and the demand for them among institute lecturers has been such as to justify this action.

Correspondence has been opened with representatives of foreign nations to secure information regarding methods of promoting agriculture in those countries. Data have also been received from the principal steam railway systems of the United States and Canada showing the steps they have taken to promote agricultural interests in the sections through which they run. The institute specialist has visited during the year 23 States and 1 Territory for the purpose of attending conventions of agricultural representatives, and has delivered before these conventions 29 addresses.

## THE ASSOCIATION OF COLLEGES AND STATIONS.

The eighteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at Des Moines, Iowa, November 1–3, 1904. This was the first meeting under the new constitution, which reduces the number of sections from five to two, and the advantage of the new plan was very marked in enabling the delegates to follow each discussion more closely and in concentrating the deliberation upon questions relating to the administration of the colleges and stations, their general management, and methods of work.

The papers and discussions at this convention were concerned mainly with (1) the extension features of agricultural education, including the teaching of elementary agriculture in the public schools, upon which the standing committee on methods of teaching agriculture presented a report; (2) improvement of plants and animals; and (3) the amount of teaching desirable for station workers to do. A brief account of the Des Moines meeting is given on page 256.

## THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations has been larger in amount and more varied in character than ever before. It has included the supervision of station expenditures, necessitating visits by inspectors to every experiment station in the United States; advisory relations with the stations involving numerous conferences and a large amount of correspondence with station officers; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular periodicals, bulletins, and circulars; the management of experiment stations in Alaska, Hawaii, and Porto Rico; special investigations on the nutrition of man and on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories; the promotion of the interests of farmers' institutes throughout the United States, and the preparation of two exhibits, illustrating the work of the Office, for the Louisiana Purchase Exposition at St. Louis.

The recent work of the Office in relation to agricultural education has been directed mainly toward the better classification and the extension of courses in agricultural engineering and agricultural economics, and the promotion of secondary and elementary instruction in agriculture. During the year the claims of some phases of agricultural instruction to a place in the common school courses were presented in addresses to not less than 4,000 teachers and school officers, and by means of publications to a much larger number. Much progress has been made also in bringing the Department into more helpful relations with the farmers' institute movement in the United States, as a result of which the ways in which the Department can aid this movement have been more clearly defined.

The original investigations of the Office have been increased not only by the extension of the work already in hand, but also by the addition of investigations in drainage, which are widespread in their application, both in the humid regions of the East and in the irrigated regions west of the Mississippi.

The preparation of the two exhibits in cooperation with the Association of American Agricultural Colleges and Experiment Stations for the Louisiana Purchase Exposition, and of a number of special publications to be used in connection with these exhibits, put heavy additional labor upon nearly every member of the Office staff, but the exhibits were of great value in giving publicity to the work of the Office in relation to agricultural education and research. A brief account of the general business of the Office will be found on page 49, and details of its operations are given in other portions of this report.

## EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

In Alaska experiment stations were maintained at Sitka, Kenai, Rampart, and Copper Center, and cooperative experiments were conducted on Wood Island. The results of the year tended to confirm the possibility of growing hardy vegetables in nearly all parts of the Territory south of the Arctic Circle, and hardy cereals and an abundance of forage for live stock in many localities. There is also increasing evidence of the feasibility and desirability of establishing animal industry in the Territory.

In Hawaii considerable progress has been made in improving the facilities for station work and in developing new work, especially with bananas, tobacco, grasses and forage plants, and soils. Studies have been made of fungus diseases and certain insect pests of coffee, sugar cane, and other economic plants, and a bulletin has been published on the leaf hopper of sugar cane.

The staff of the Porto Rico Station has begun the investigation and introduction of new and improved varieties of horticultural products, the promotion of improved cultural methods, the cultivation and improvement of coffee, and the study of life histories of injurious fungi and insects and means for their repression. A study of methods of combating the coffee-leaf miner has resulted in the discovery of an effective parasite which, it is believed, by careful propagation and distribution, will aid very materially in checking the ravages of this most serious enemy to coffee cultivation. Much progress has been made in draining the farm, installing an experimental irrigation system, and otherwise preparing the land for experimentation.

## NUTRITION INVESTIGATIONS.

During the last fiscal year the inquiry regarding food and nutrition of man, conducted under the auspices of this Office, has been continued on much the same lines as in the previous years, the investigations as heretofore having been under the immediate charge of Prof. W. O. Atwater. Attention has been devoted mainly to the study of physiology, hygiene, and the economics of nutrition, the chief object of the inquiry being to discover the fundamental laws of nutrition and their economical and sociological application to the health and well-being of mankind. Attention has been paid more particularly to cooking experiments, dietary studies, digestion experiments, and investigations with the respiration calorimeter on the transformations of matter and energy in the human body.

In addition to the experimental work a large amount of editorial work is required in the calculation of the results of experiments, the preparation of experimental data for publication in a technical and popular form, and in other ways.

The method of cooperation by which the work of investigation has been distributed among various educational, scientific, and similar institutions in the United States has, as hitherto, given most excellent results and a large amount of investigation has been carried on. In a considerable measure this has been made possible by the generous support of the cooperating institutions which have contributed in some cases money, and in practically all cases the use of laboratories, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance. Had funds been available it would have been possible to extend considerably the cooperative investigations, as other institutions have expressed a readiness to join in such enterprises provided a comparatively small amount could be allotted to them. However, with the funds at present available it was not found possible to extend the work beyond its present limitations.

### THE WORK AT DIFFERENT PLACES.

In addition to editorial work, the Washington office has had the general supervision of the plans and expenditures for the nutrition investigations. Bibliographical and other data have been collected; the current literature of the subject of nutrition has been reviewed, and abstracts made partly for use in the Experiment Station Record and partly for other purposes in connection with the inquiry, as seemed desirable. The growth of interest in the nutrition investigations is shown by the constantly increasing corespondence which, as well as the distribution of publications, is attended to from the Washington office.

In connection with the Department of the Interior, an extended series of dietary studies was made at the Government Hospital for the Insane, and the results were prepared for publication in bulletin form.

The nutrition investigations carried on at the University of California by Prof. M. E. Jaffa and his associates during the past year form part of a series intended to cover two years, the digestibility of fruits and nuts and their value as part of a mixed diet being the general subject under investigation. The nutritive value of a diet consisting almost entirely of fruits and vegetables was also studied. Thirty-five digestion experiments and four dietary studies have been made.

Fruit and nuts may be made a very useful part of the diet. Aside from the work undertaken at the University of California comparatively little attention has been paid to the study of the nutritive value of these foods. California furnishes such an abundant variety of both fruits and nuts that the conditions are very favorable for the investigations, and it is believed that the inquiry now in progress will demonstrate the dietetic value of fruits and nuts and lead to their more general and intelligent use in American households. The wise use of fruits, fresh and preserved, as a part of the diet rather than as food accessories would, it seems fair to say, add to the attractiveness and wholesomeness of the diet, and would probably be of benefit also from the standpoint of economy.

The work at Middletown, Conn., in which Wesleyan University, the State of Connecticut, and the Carnegie Institution of Washington cooperated with this Department, was conducted under the direction of Prof. W. O. Atwater, chief of nutrition investigations, and has included the planning and direct supervision of the cooperative investigations throughout the country; carrying out of special studies with the bomb and respiration calorimeters; improvements in apparatus and methods of inquiry; editorial work, including calculation and verification of data and preparation of results for publication; compilation of results of nutrition investigations in this and other countries, and correspondence and other administrative work.

In connection with the respiration calorimeter investigations a number of improvements in apparatus have been introduced, one of the most valuable being a device by which the subject can weigh himself while in the respiration chamber, the weighings being accurate, within 2 or 3 grams. The method is also adapted to weighing the absorber system inside the chamber with great accuracy. The actual experimental work has included eleven experiments with three different subjects, covering a period of twenty days within the apparatus. In one experiment the subject remained in the apparatus thirteen days and fourteen nights. The experimental conditions have varied from fasting and extreme quiet to abundant diet and unusually hard work, and furnish valuable data regarding the comparative value of different nutrients and the amounts of protein and energy required for the production of different amounts of work.

In addition to the complete metabolism experiments a number of experiments of about twelve hours each were made to study the amounts of heat radiated from the body under different conditions of lying, sitting, standing, or operating the bicycle ergometer, such experiments having to do with the study of the efficiency of the human body as a machine, its energy requirements, and the effect of various circumstances on the energy output.

In connection with the experiments considerable time has been devoted to a study of the method of partial drying of samples of food, etc., in vacuo for analysis, and the results obtained indicate that the method as followed is much more satisfactory than drying samples by heat as in the more common method.

Twenty-five experiments have also been carried on during the year with different subjects to secure data regarding the digestibility of cereal breakfast foods, fish, and poultry.

At the University of Illinois Prof. H. S. Grindley and his associates have continued the investigations of the losses and chemical changes resulting from cooking meat and the influence of different methods of cooking upon its nutritive value, fifty-eight experiments having been made. The work has been carried on under very favorable circumstances, as in addition to the use of a new and well-equipped laboratory the university has contributed $2,000 to the nutrition investigations, and furthermore the experiment station has furnished without charge the meat used for the investigations, the animals from which the portions of meat were taken having been bred, grown, fed, and slaughtered under known conditions. Valuable assistance has been rendered by the department of household science of the university.

The investigations with meat have shown that the losses of nutrients vary markedly with different methods of cooking, and, together with the results of Professor Grindley's earlier studies, furnish valuable data for the economical preparation of meat for the table, especially in institutions where large quantities are cooked at a time and economy is necessary.

In addition to the cooking experiments studies have been made of the kind and amount of proteids in broth of different sorts from cooked meat and in water extracts of uncooked meats, a valuable feature being the improvement of the methods for use in determining the nitrogen of meat and meat products.

At the University of Maine Prof. C. D. Woods and his associates have carried on experiments which have to do with the digestibility of different cereal breakfast foods. The work has included thirty-four natural and thirty-four artificial digestion experiments, and has furnished results of much value. In addition to the experimental work reports of the dietary studies and digestion experiments with lumbermen and of digestion experiments with bread were prepared.

The cereal breakfast foods studied have included some of the sorts very commonly used, and the results obtained furnish valuable data for judging of the value of this important class of foods.

The dietary studies and digestion experiments with Maine lumbermen are of unusual interest, since they were carried on with men performing severe physical work under more or less trying conditions and exposure and living upon a diet which though abundant was very simple, being made up of a few staple foods of which the most important were perhaps beans and bread. The amounts eaten were fairly large, as might be expected from the character of the work performed. As regards thoroughness of digestion, little difference was observed between these men and others who have been studied under more usual conditions.

At the University of Minnesota Prof. Harry Snyder has studied especially the digestibility and nutritive value of cereal breakfast foods and of macaroni flour—i. e., bread prepared from macaroni wheat—and has made thirty-one digestion experiments. He has also made a milling experiment with macaroni wheat and an experiment on the preparation of macaroni from flour thus prepared.

The studies of cereal breakfast foods are especially interesting, and the results, taken in connection with those obtained at Middletown and the University of Maine, will go far toward settling the interesting question as to the value of this class of foods as compared with bread, macaroni, and other common cereal preparations. In connection with the work attention has been paid to the comparative economy and wholesomeness of different methods of marketing these foods, the cost of the nutrients furnished as compared with flour, meal, and the more common foods, the influence of methods of preparation on flavor, and related topics.

The work with macaroni wheat has furnished interesting data regarding the value of this class of wheat and the possibilities of extending its use.

Dr. H. C. Sherman, of Columbia University, New York City, has continued his collection of data regarding the protection of proteids in the body.

At the University of Tennessee Prof. C. E. Wait has continued the investigations along the same lines as in previous years, namely, twenty dietary studies of white families of limited means living in mountain districts, and twelve experiments on the digestibility of legumes.

Especial interest attaches to the studies of the digestibility of legumes, as hitherto little data has been available regarding the thoroughness with which this important class of nitrogenous foods is utilized by the body. In addition to other legumes, Professor Wait's work has included cowpeas, a food product of great importance in regions where it is grown and one whose use it seems could be profitably extended to regions where it is at present little known.

### FOOD AND NUTRITION PUBLICATIONS.

The food and nutrition publications issued during the past year have included 5 techincal bulletins, 1 farmer's bulletin, an article for the Yearbook of the Department, an article for the Annual Report of the Office of Experiment Stations, and one for distribution at the St. Louis Exposition. The subjects treated in these publications are as follows:

Dietary Studies in Boston and Springfield, Mass., Philadelphia, Pa., and Chicago, Ill.; Further Investigations among Fruitarians at the California Agricultural Experiment Station; Experiments on the Metabolism of Matter and Energy in the Human Body, 1900–1902; Experiments on Losses in Cooking Meat, 1900–1903; Studies of the Digestibility and Nutritive Value of Bread at the Maine Agricultural Experiment Station, 1899–1903; Poultry as Food; Wheat Flour and Bread; Nutrition Investigations at the Government Hospital for the Insane, Washington, D. C., and Investigations on the Nutrition of Man in the United States.

The following was submitted for publication, but was not actually printed during the fiscal year: Canned Fruit, Preserves and Jellies: Household Methods of Preparation.

## IRRIGATION AND DRAINAGE INVESTIGATIONS.

### IRRIGATION.

The regulation of the water supplied to soils for the growth of crops by means of irrigation and drainage, as related to tillage, is a factor in crop production of universal importance. Investigations of the best manner of accomplishing the results desired through irrigation and drainage were carried on during the past year under the direction of Dr. Elwood Mead in thirty different States and Territories and two of our insular possessions. In California, Oregon, Washington, Nevada, Utah, Colorado, Wyoming, Montana, South Dakota, Nebraska, Kansas, New Mexico, Arkansas, Iowa, Wisconsin, Indiana, New Jersey, and in the islands of Porto Rico and Hawaii, this work was conducted under cooperative arrangements with the State agricultural colleges or experiment stations. In Idaho and Wyoming this Office cooperated with the State engineers' offices. In California and Nevada special cooperative appropriations were made by the States for extending this work. In addition to these cooperative studies work was carried on by the agents of the Department in Texas, Louisiana, Mississippi, Missouri, Illinois, Alabama, Florida, Georgia, South Carolina, and West Virginia.

In company with a representative of the Bureau of Plant Industry, Mr. C. G. Elliott, engineer in charge of drainage investigations, made a study of the drainage problems of the fruit and vegetable lands bordering the Everglades in Florida.

In collaboration wtih the Bureau of Chemistry a large number of samples of irrigation waters were collected by the field agents of this Office and analyzed by the Bureau of Chemistry, to determine the amount and influence on plant and animal life of the impurities carried.

### THE DUTY OF WATER.

The measurements of the quantity of water used under ordinary practice were continued in nearly all of the arid States, in districts where this information is needed as a guide in the adjudication of water rights, to serve as a basis for fixing the dimensions of new canals, or for making comparisons between the average duty under existing practice and the possible duty under tests being made of more skillful and economic methods. These records of existing practice were supplemented by experiments to determine the absolute quantity of water which, under given conditions of soil and climate, will produce the largest yield. In these experiments the quantity of water applied varied from 2 to 60 inches, or from the lowest limit of economy in actual practice to about the maximum quantity of water used by irrigators in anything resembling good practice. These experiments will be continued until the approximate limits of economy in water, beyond which saving becomes unprofitable, are ascertained, and also the other extreme, beyond which additional application of water becomes injurious, is approximately determined. A report of these investigations is given in the subsequent pages of this report, and is illustrated by photographs which show how varying the quantity of water affects the growth of crops. This information is needed to determine the kind of water-right contracts best suited to different localities. Where there is more irrigable land than water to irrigate it, lessened use and a high duty, even with diminished yield, may be the most profitable system, because of the large increase in cultivated acres which it makes possible; while, on the other hand, where the water supply is abundant, a knowledge of the extent to which a liberal use of water increases yields is desired.

Another line of experiments has been carried on to determine the influence on the quality of fruits and grains of varying the time of irrigation as well as the amount of water applied. While not conclusive, the results of these experiments give reason for believing that through skillful handling of water the quality of both fruits and grains can be progressively improved. These tests have been supplemented by comprehensive inquiries to ascertain the experience of practical fruit growers, the investigation with respect to fruits being made by Prof. E. J. Wickson, horticulturist of the California Experiment Station, and those on grains under the direction of J. A. Widtsoe, director of the Utah Experiment Station. Heretofore soft wheats have been largely grown where irrigation is practiced. It is hoped to change this and produce better varieties either through the adaptation of hard wheats to irrigation or through the progressive improvement of soft wheats by better methods of applying water.

The studies of preparing land for irrigation and the collection of data regarding the cost of doing this have been continued. The results of these studies are proving of great practical value to farmers. Thousands of beginners wish to know how to prepare their land for applying water. This not only involves the giving of information regarding implements to be used, but the selection of the method to be adopted. There are in all in this country about thirty different methods of applying water to land, these being modifications of four general systems. The soil, the climate, the kind of crops to be grown, and the topography of the surface are all factors which enter into the selection of the method to be employed. The check method seems to be best adapted to light, sandy soils having slopes of from 3 to 6 feet to the mile. In the greater part of the country the flooding of the land from small field ditches is the popular system; probably three-fifths of all the land irrigated is watered by this method, yet in certain sections of the country, notably in the San Joaquin Valley, in California, this method is unknown. The furrow method is generally used in the irrigation of orchards and for all cultivated crops, and has one marked advantage over flooding or checks in lessening the loss from evaporation, the experiments in California in 1904 showing a saving in irrigation through deep furrows of 25 per cent. At present the arbitrary difference in irrigation methods to be found in districts having the same natural condition seems to come largely from the influence of the method first adopted, the tendency of later comers being to follow the plan they see in operation. The bulletins describing different methods are causing land to be prepared and water applied in a much more intelligent and efficient manner.

### PUMPING WATER FOR IRRIGATION.

The studies of irrigation by pumping carried on during the past year have taken a wide range and included laboratory tests of the efficiency of different makes of pumps, field records showing the quantity of water lifted, the number of acres irrigated, the amount of fuel used (with its cost), and the value of the crops grown. These experiments and inquiries in regard to pumping were carried on in California, New Mexico, Texas, Colorado, Kansas, Arkansas, Louisiana, Nebraska, and Wyoming, part of the work being under the direction of the engineers and experts of this Office and a part in cooperation with the State University of California and the State experiment stations of New Mexico, Kansas, and Arkansas.

During the past season statistics of the cost of pumping water for irrigation were obtained from over 1,000 pumping plants. These embraced nearly every kind of power and about every type of pump. The fuel included straw, brush, coal, wood, gasoline, and crude petroleum; the power, steam, gasoline, windmills, and electricity. The importance of pumping is due to the fact that in many sections of the country wells furnish the only available water supply, and to the further fact that improvements in machinery have so lessened the cost of pumping that many farmers are employing it where it is possible to obtain water from gravity canals. It is believed that this extension of pumping is destined to continue. Over 13,000,000 acres of land in India—about 25 per cent of the entire irrigated area—is irrigated from wells, and about 8,000,000 acres additional is irrigated from small reservoirs. In the Madras Presidency alone there are 676,000 wells supplying water for irrigation, nearly all of which is lifted by men or animals.

The extension of pumping depends on whether or not it can be made to pay. If it can be, it will be a most influential factor in extending the area of settlement in the semiarid region. The irrigation of small tracts in conjunction with larger areas cultivated by dry farming will make it possible to grow more diversified and higher priced products, to maintain fruit and shade trees, thus beautifying the landscape and rendering the social and industrial conditions of farm life far more attractive. This kind of irrigation will pay as an insurance where the expense would otherwise be prohibitive.

The pumping investigations are dealing with two problems. One is the most efficient type of machinery for lifting large volumes of water from streams or canals. The other is the development of cheap, simple methods of lifting water for the irrigation of small areas and for lifting water from sources where the supply which can be delivered in any given unit of time is restricted. California, Arizona, the rice districts, and the sugar plantations of our insular possessions are the most promising fields for the development of irrigation through the construction of large pumping works, either by corporate capital or farmers' cooperative associations. Here the fundamental problem is efficiency. First cost and payment for mechanical skill in operation are subordinate considerations.

The semiarid region is the field for experiment to determine the best type of individual pumping plant. Here the investigations are being directed to determine the possibilities of windmills, gas engines, and electricity as motive power. The results of windmill irrigation at Garden City, Kans., Stockton, Cal., and a number of other localities where they have been extensively tried, render it desirable that the full possibilities of this form of power be determined, and this is being done by both field and laboratory tests in cooperation with the State Agricultural College of Iowa.

### IRRIGATION IN THE HUMID PORTIONS OF THE UNITED STATES.

In 1903 the legislature of Wisconsin appropriated $2,500 a year for two years for an investigation of cranberry irrigation by the Wisconsin Experiment Station. This Office has been cooperating with that station in studying the conditions needed to make this industry profitable. Cranberry growing is largely dependent on such control of water as will permit of fields being flooded quickly and drained thoroughly. The work carried on during the past season has included the collection of information about the amount of water used, losses by seepage and evaporation, the effect of standing water of different temperatures on the berries and vines, and the influence of irrigation and drainage in preventing injury from frost.

In cooperation with the New Jersey Experiment Station similar studies are being made in the cranberry districts of New Jersey.

In other sections of the humid States the Office has given advice about irrigation methods, about the selection and installation of pumping machinery, and has continued its collection of data to determine the profits of irrigation in the East. Last year was an unfavorable one because of the excessive rainfall.

### LEGAL AND ECONOMIC QUESTIONS.

At the request of the Modesto and Turlock irrigation districts in California this Office began in 1904 a study of the legal and economic questions connected with canal management, the purpose in this case being to aid the farmers in these two districts to perfect a system of administration which would prevent waste of water and controversies between farmers. As there are 270,000 acres of irrigable land in these districts, and the canals will in time serve many thousand irrigators, the working out of an effective distribution system is an important and somewhat complicated matter. As a first step in working out such a system records of the quantities of water delivered to each user were kept during 1904 by an agent of this Office, and on his recommendation the districts have adopted a system for keeping records of the flow of water distributed to each user and the time during which the water is used. These studies are to be continued in California, Washington, and Oregon in sections where the land under large canals is being brought under cultivation.

The most conspicuous weakness of our present irrigation development grows out of our failure to recognize that irrigation is an organized industry, that the relations between water users should be clearly defined, and that the same administrative regulations for the distribution of water from a river or large canal system are needed as are required in the transmission of goods by railways and express companies. In this respect our systems are far inferior to those of older irrigated districts.

The investigations of methods of distributing water from rivers in Colorado, Wyoming, and Nebraska show that there are great dangers of water monopoly and a necessity for more effective public control, and that a lack of a strict enforcement of priorities causes great waste in the use of water and costly and vicious litigation between farmers.

In cooperation with the State engineer's office a study was made of the practical working of the Idaho State law. An agent of this Office was appointed water commissioner, and in that position dealt practically with the problems of distribution. One of the greatest difficulties in just division of water was the lack of proper measuring devices. Another was the rendering of decrees by the court giving to appropriators excessive amounts of water and recognizing the validity of sales of these surplus appropriations. In cases where sales were made it resulted in injustice to subsequent appropriators, and where they were not made there was a constant temptation on the part of the irrigator to use water excessively, in order to divert all that was decreed to him and hence maintain his right thereto until it could be sold.

One feature which needs to be studied is the methods of organizing farmers under laterals in order to lessen the expense of canal management and the losses of time and water in irrigation by a satisfactory system of rotation such as prevails in Italy and is described in Bulletin 144 of this Office.

The growing diversion of water from streams in Louisiana to irrigate rice has called attention to the inadequacy of the State water laws, and an agent of this Office has been for two years past studying the legal and economic problems of this State for the purpose of recommending additional legislation.

The chief of this investigation has been called upon to advise State commissions with respect to irrigation legislation, and is now detailed as an engineer to aid the Government in the litigation over the Arkansas River, in which the State of Kansas, the State of Colorado, and the United States Government are all parties.

### DRAINAGE.

The drainage investigations carried on during 1904 dealt with the engineering questions incident to the location and construction of field drains and the legal and economic problems which have to be solved where united action of many landowners is a necessity. Personal examinations of conditions, and in some cases surveys, have been made by engineers connected with the Office in order to render practical assistance and promote the best practice. The importance of drainage for irrigated land is found to be more urgent as these investigations proceed.

Examination of saturated land in Cache, Emery, and Washington counties, Utah, was made in 1904, and soil measurements in the Fresno district, California; Sunnyside, Wash.; Truckee and Carson valleys in Nevada, and Yellowstone Valley, Montana. By means of records of the rise and fall of soil water, obtained through the sinking of wells in the irrigated districts, the influence of excessive irrigation on the water plane has been studied and information obtained which will furnish a working basis for fixing the dimensions of drainage works to relieve the swamped areas. The season of 1904 demonstrated the practical value of these drainage studies, in every instance the works constructed according to the recommendations of the Office having proved effective, and considerable bodies of land which had been rendered worthless have been in this way restored to fertility. In one instance a tract, which in 1903 produced no crop because of the rise of seepage water, in 1904, after being drained, produced a crop which sold for $600 an acre.

In company with a representative of the Utah Experiment Station, an examination of the swamped areas of a number of Utah counties was made by Mr. C. G. Elliott in the spring of 1904. This showed that drainage is one of the most necessary irrigation improvements in Utah, there being scarcely an irrigated valley in the State in which some of the best land has not become too wet for cultivation or from which only uncertain crops of inferior value can be obtained. In a number of instances attempts to drain these swamped areas have proven unsuccessful. The reasons for this are explained in a subsequent portion of this report. In order to determine how best to overcome the obstacles encountered, an experiment in drainage has been inaugurated in Cache County, where tile drains have been put down and their effects on the removal of seepage water are being studied.

During the past year there has been a marked extension of drainage studies in the humid portions of the United States. These have included examinations and reports on the drainage problems of districts in Nebraska, Iowa, South Dakota, Wisconsin, and Illinois, and in cooperation with the engineering department of Purdue University a comprehensive inquiry into the results of tile drainage in the Mississippi Valley during the past twenty-five years has been inaugurated. Requests have been received that this investigation be made to include problems connected with the construction of dredged drain ditches and the best methods of maintenance and repair. Should means be provided, it is intended to undertake this in connection with a study of the best means of reclaiming the Kankakee marshes of Indiana and some of the swamped areas in other States of the Mississippi Valley.

During May and June of 1904 an investigation was made of the drainage conditions of the Illinois River bottom lands, extending from Peoria to the mouth of the river. These lands vary from 1 to 3 miles in width and lie from 8 to 20 feet above low water, while from 1897 to 1904 the high-water line varied from 13.7 to 19.9 feet, during four years reaching the 18-foot mark. When cultivated the higher parts of the bottom yield crops about two years out of three, but the lower parts flood so frequently that it is not profitable to cultivate them; but if these lands are protected by dikes and properly drained they produce large crops of corn and wheat. On account of the slight fall of the river, the level surface of the bottoms, and their slight elevation above low water the reclamation of these lands is expensive and difficult. Near Pekin, Havana, and Beardstown organizations have been formed under the provisions of the State levee and drainage laws and attempts made to reclaim tracts of this land by means of levees, drain ditches, and pumps. The results of these improvements have not been satisfactory, because the levees were not built high enough and in some instances the pumping stations were not properly located. The investigation was to aid in determining the nature of the improvements required. The reports show that the complete reclamation of these lands is feasible and can be accomplished at a profit, the estimated annual net profit for the districts examined being $2.26 per acre. As the problems to be dealt with and the nature of the work necessary to success are now better understood by landowners, more satisfactory results will doubtless be obtained in the future than were realized in the first attempts.

### OTHER BRANCHES OF RURAL ENGINEERING.

The studies of the use of power in pumping and irrigation shows that many millions of dollars are spent by farmers each year in the purchase of this class of machinery alone. They also show how important it is that our schools and colleges give increased attention to the training of farmers in these matters. Through lack of knowledge of mechanical principles and skill in the use and repair of machinery, it breaks down when it should not, and wears out before the natural term of its service is completed. The cost of this machinery to the farmer is one of his heaviest outlays, and the gain to the country as a whole, by increasing its life through better care or more skillful operation, would in the aggregate amount to millions of dollars each year. The difficulty of providing for this is greater to-day than ever before because of the more complicated types of machinery used. The traction engine, the steam plow, and the automobile, the machinery used in dairies, in the cultivation and harvesting of rice, in the growing of sugar beets, and the manufacture of beet sugar, are illustrations of the momentous changes in the character of farm machines which have taken place in the past fifty years.

Nor is this need of increased knowledge of rural engineering confined to farm machinery. The changes which are taking place in the character of farm buildings make a knowledge of structural design, of ventilation, and of the cost and durability of different materials all matters of interest to the individual farmer and of great importance to the country as a whole. That this is being recognized practically is shown by the large number of inquiries on these matters which come to the Department, and which are referred to this Office for answer. It is also shown by the increased attention being paid in the agricultural colleges to courses of instruction in rural engineering. It is one of the functions of this Office to aid these institutions in increasing the efficiency of their different lines of work, and in no direction has there been greater inquiry during the past year than in the questions relating to instruction and experiment regarding farm structures and machinery. It is to be hoped that funds will be provided in the near future by Congress which will permit of the employment of one or more experts in this branch of rural engineering, and thus enable the experts in drainage and irrigation, who now have to deal with these questions, to give their entire time to work in their special fields.

### IRRIGATION AND DRAINAGE PUBLICATIONS.

During the year ending June 30, 1904, the following publications on irrigation and drainage were issued: Egyptian Irrigation; Plans of Structures in Use on Irrigation Canals in the United States; Report of Irrigation Investigations for 1902; Storage of Water in the Cache la Poudre and Big Thompson Rivers; Acquirement of Water Rights in Arkansas Valley in Colorado; Drainage of Farm Lands; Supplemental Report on Drainage in the Fresno District, California; Irrigation in the Valley of Lost River, Idaho; Review of Irrigation Investigations for 1903; and Preparing Land for Irrigation.

Additional bulletins prepared and submitted for publication were the following: Irrigation in Northern Italy, Part I; Preparing Land for Irrigation and Methods of Applying Water; Current Wheels: Their Use in Lifting Water for Irrigation; Report on Drainage Investigations for 1903; Report on Irrigation Investigations in the Humid Sections of the United States; and Irrigation and Drainage Investigations of the Office of Experiment Stations.

The new matter published contains 717 pages and the reprints 330 pages.

# WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.

This is the tenth annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made by the Director, the assistant director (E. W. Allen), W. H. Beal, and Walter H. Evans. The compilation of the statements regarding the individual stations has been made by Dick J. Crosby.

## OFFICE OF EXPERIMENT STATIONS.

### GENERAL OUTLOOK.

The business of the Office of Experiment Stations has been larger in amount and variety during the past year than at any previous time in its history. The great increase in the original investigations under its supervision, as well as in the world's literature of agricultural science, which it is the duty of this Office to review, has made necessary the publication of a much larger number of technical and popular documents. A gratifying recognition of the importance of the work of this Office, as well as of agricultural colleges and experiment stations, has been made by Congress in its recent provision for the annual printing of this report. The claims of agricultural education to more definite and adequate recognition in our public school system, as well as in our higher educational institutions, have been more directly and widely presented to teachers and school officers than ever before. In cooperation with the Association of American Agricultural Colleges and Experiment Stations a report on the Teaching of Agriculture in the Rural Common Schools was prepared and published as a circular of this Office. The growing interest in this subject throughout the country is shown by the demands for information, which have exceeded the ability of this Office to meet with its present resources. Much progress has been made in bringing the Department into closer touch with the farmers' institutes in the several States, and the need of a stronger organization for bringing the results of the Department's home work to the great multitude of farmers who attend the institutes has been clearly revealed. The affairs of the agricultural experiment stations in Hawaii and Porto Rico have been successfully managed by the special agents in charge, and already useful results of investigations have been published. In Alaska evidence of the feasibility of establishing animal industry has been obtained, and the great desirability of experimental inquiries along this line, which will forestall the expense and discouragement likely to attend private ventures, has been demonstrated. In the nutrition investigations steady progress has been made in the elaborate and fundamental inquiries regarding the laws of human nutrition with the respiration calorimeter and in the more directly practical studies of the nutritive value of cereals, fruits, and meat. The great importance of these investigations is being recognized, not only by scientific and educational institutions throughout this country, but also in many foreign countries. As the result of recent action by Congress the irrigation and drainage investigations have been put on a more permanent basis. In irrigation a definite and very important field of engineering problems directly relating to the most effective and economical utilization of water in the production of crops has been marked out, and lines of work not previously undertaken anywhere have been entered upon. Great enterprises, involving the reclamation of large areas of fertile land, are being aided by the drainage investigations. The problems of agricultural engineering involved in the construction and use of farm machinery and farm buildings and the applications of power to agricultural purposes are coming into greater prominence in our vast agricultural regions, where scarcity of labor is every year a greater drag on agriculture. These problems should be definitely investigated by this Department, and it is hoped that funds will soon be provided for this purpose. A large amount of work has been done in connection with the preparation of two exhibits for the Louisiana Purchase Exposition. A description of these exhibits is given on page 687.

## LINES OF WORK.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations at Alaska, Hawaii, and Porto Rico; special investigations on the nutrition of man and on irrigation and drainage, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories, and the promotion of the interests of farmers' institutes throughout the United States.

## INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

| | |
|---|---|
| For the general business of the Office (including farmers' institutes) | $45,000 |
| For the Alaska experiment stations | 15,000 |
| For the Hawaii Experiment Station | 15,000 |
| For the Porto Rico Experiment Station | 15,000 |
| For nutrition investigations | 20,000 |
| For irrigation investigations | 65,000 |
| Total | 175,000 |

## PUBLICATIONS.

During the year the Office published 57 documents, aggregating 5,339 pages, as compared with 44 documents, containing 4,112 pages, the previous year. These documents include 12 numbers of Experiment Station Record, with a combined index of the first 12 volumes of the Record, 16 technical bulletins, 1 bulletin of the Porto Rico Experiment Station (English and Spanish editions), 2 reports, 6 farmers' bulletins (including 3 numbers of the subseries Experiment Station Work), 8 circulars, and 3 articles for the Yearbook of the Department. One other number of the Experiment Station Record, 5 technical bulletins, 2 farmers' bulletins, 2 circulars, and 4 miscellaneous documents, containing about 600 pages, were prepared and submitted for publication before the close of the fiscal year. The policy of reprinting separates of individual articles contained in larger reports has been continued with satisfactory results. Fifty-four such separates, aggregating 1,241 pages, have been reprinted in editions of varying size to meet the actual demands for the articles. Several documents, particularly those relating to the work and expenditures of the State agricultural experiment stations, as well as those of Alaska, Hawaii, and Porto Rico, which were formerly printed separately by Congress, were combined in the Annual Report of the Office of Experiment Stations, for the printing of which Congress has now made special provision.

Several of the earlier technical and farmers' bulletins of the Office were exhausted during the year and were reprinted, in many cases with more or less important corrections.

*Experiment Station Record, Vol. XV, pp. 1247.*—This contains abstracts of 380 experiment station bulletins, circulars, etc., 47 annual reports of the stations, 181 publications of this Department, and a very large number of foreign publications. In all there were 4,376 abstracts, classified as follows: Chemistry, 296; botany, 101; fermentation and bacteriology, 23; zoology, 70; meteorology and climatology, 109; air, water, and soils, 159; fertilizers, 155; field crops, 256; horticulture, 387; forestry, 116; seeds and weeds, 61; diseases of plants, 209; entomology, 490; foods and nutrition, 296; animal production, 297; dairy farming and dairying, 233; veterinary science and practice, 789; technology, 8; agricultural engineering, 170; miscellaneous, 151.

This volume contains nine leading articles, as follows: New agricultural building at the University of Wisconsin, annual meeting of the American Veterinary Medical Association, new building for farm mechanics at the Iowa College of Agriculture and Mechanic Arts, convention of Association of American Agricultural Colleges and Experiment Stations, convention of Association of Official Agricultural Chemists, agricultural science at the St. Louis meeting, new dairy barn at the Kentucky Station, new buildings of the Department of Agriculture, and respiration calorimeter at the Pennsylvania Experiment Station. The following topics are discussed in the editorials: The mission of the farmers' institute; organization of farmers' institutes; introduction of agriculture at the Mount Hermon School; September meetings of scientific bodies—National Irrigation Congress, American Veterinary Medical Association, International Congress of Hygiene and Dermography, American Pomological Society, and Society of Horticultural Science; irrigation in Italy; State aid of the experiment stations; need of increased funds for the stations; experiment station work in Alaska; farm mechanics as a department of agricultural instruction; report of the Secretary of Agriculture for 1903; the personnel of the Department of Agriculture; the American association meeting at St. Louis; rural economics at the St. Louis meeting; acquisition of the nitrogen of the air by calcium carbid; agricultural research and the Carnegie Institution; Government aid to agriculture in Hungary; investigations on the flow of maple sap; work of the bureau of agriculture in the Philippines; experiment stations in the Philippines; a card index to periodical literature on agricultural science; bimonthly list of experiment station publications; a respiration calorimeter for farm animals; rural economics as a department of agricultural education; instruction in rural economics in European countries; the agricultural appropriation act, 1904–5; inauguration of experiment station work in Cuba; an experiment in secondary agricultural instruction; Levi Stockbridge, deceased; histological studies in relation to food adulteration; Emile Duclaux, deceased; general index to Experiment Station Record; a decennial summary of station work, and the experiment station in the rôle of newspaper editor.

*Miscellaneous technical publications.*—These included Instruction in Agronomy at Some Agricultural Colleges; Legislation Relating to Farmers' Institutes in the United States and the Province of Ontario, Canada; Organization Lists of the Agricultural Colleges in the United States; Proceedings of the Eighth Annual Meeting of the American Association of Farmers' Institute Workers; Special and Short Courses in Agricultural Colleges; Proceedings of the Seventeenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations; A Summary of Recent American Work on Feeding Stuffs; Experiment Station Work with Apples; Progress in Agricultural Education, 1903; Development of the Text-book of Agriculture in North America; Agricultural Economics as a Subject of Study in the Agricultural College; Instruction in Agriculture in Land-grant Colleges and Schools for Colored Persons, and publications on nutrition and irrigation, noted on pages 39 and 48.

*Bimonthly list of station publications.*—This is a new series, similar to the monthly list of publications issued by this Department and containing a list of the publications of the agricultural experiment stations in the United States. Four numbers were issued between January 1, 1904, and July 1, 1904.

*Farmers' Bulletins.*—These included three numbers of Experiment Station Work and a revision of Farmers' Bulletin No. 21, on Barnyard Manure.

*Card index.*—Copy for 1,000 cards of the index of experiment station literature was prepared during the past year. The number of index cards distributed has reached 24,600.

# THE AGRICULTURAL EXPERIMENT STATIONS IN THE SEVERAL STATES AND TERRITORIES.

NOTE.—Members of boards of trustees or other governing boards of the college who are charged with the management of experiment station affairs are indicated by an asterisk (*).

## ALABAMA.

### Agricultural Experiment Station of the Alabama Polytechnic Institute, *Auburn.*

Department of the Alabama Polytechnic Institute.

#### GOVERNING BOARD.

Trustees: Governor William D. Jelks (*ex officio President*), *Montgomery;* Isaac W. Hill (*Superintendent of Education, ex officio*), *Montgomery;* Jonathan Haralson, *Montgomery;* J. A. Bilbro, *Gadsden;* J. M. Carmichael,* *Montgomery;* W. K. Terry, *Birmingham;* T. H. Frazer, *Mobile;* N. D. Denson, *Lafayette;* T. D. Samford;* *Opelika;* R. F. Ligon, jr., *Montgomery;* Tancred Betts, *Huntsville;* William C. Davis,* *Jasper;* E. T. Glenn (*Treasurer*), *Auburn;* J. H. Drake (*Surgeon*), *Auburn;* R. W. Burton (*Secretary*), *Auburn.*

#### STATION STAFF.

J. F. Duggar, M. S., *Director; Agriculturist.*

B. B. Ross, M. S., *Chemist.*

C. A. Cary, B. S., D. V. M., *Veterinarian.*

E. M. Wilcox, PH. D., *Botanist.*

R. S. Mackintosh, B. AGR., *Horticulturist.*

J. T. Anderson, PH. D., *Assistant Chemist.*

C. LeR. Hare, M. S., *First Assistant Chemist.*

A. McB. Ransom,[a] M. S., *Second Assistant Chemist.*

Thomas Bragg, M. S., *Third Assistant Chemist.*

John H. Mitchell, M. S., *Assistant Chemist.*

C. M. Floyd, *Superintendent of Farm.*

N. C. Rew, B. S. A., *Assistant Animal Husbandman.*

Isaac S. McAdory, B. S., *Assistant in Veterinary Science.*

T. B. Rivett, *Assistant Horticulturist.*

#### GENERAL OUTLOOK.

Investigations relating to soil management and the diversification of agriculture through the introduction of animal production and new and improved plants continue to occupy a commanding position in the work of the Alabama Station. In this connection much attention is given to the use of legumes as soil renovators and as forage and to tests of pure cultures in inoculating these plants. These tests and the recently started experiments with truck crops are conducted in cooperation with the Bureau of Plant Industry of this Department, as are also the three diversification farms in the State and the experiments in the shedding of squares, blooms, and bolls of the cotton. The station is also cooperating with farmers in many different parts of the State in fertilizer experiments with cotton, sorghum, and soy beans, and in inoculation experiments with legumes.

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[a] On leave.

Plans have been made to cooperate with the Bureau of Animal Industry in cattle feeding and also in an extensive series of pig-feeding experiments in which clinical and pharmacological studies will be made; also to cooperate with the Shorthorn Breeders' Association in performing inoculation experiments to determine some of the phenomena of Texas fever. Studies by the chemist of the influence of fertilizer "fillers" on the solubility of phosphoric acid in superphosphates, and of the relation of the fertilizers used to the potash content of certain parts of the cotton plant, have recently been started. Studies by the botanist on the castor-oil bean and on the diseases of fruit trees in Alabama have been prepared for publication.

The Alabama Station is in better condition than formerly, and through its extensive cooperation with farmers, its inspection work, and the participation of its officers in farmers' institutes it is becoming widely known and is deriving much benefit from its broader acquaintance. At the close of the last institute season a ten-day round-up institute was held at the station. This was in the nature of a school of instruction, and was so successful that it will be repeated next year. The college and station are also coming into closer relation with the district agricultural schools in the State, and through cooperation with them a system of agricultural institutions is being developed which has great ultimate possibilities for the improvement of agricultural conditions in Alabama.

## LINES OF WORK.

The principal lines of work conducted at the Alabama Station during the past year were as follows: Chemistry of fertilizers and farm crops; botany—grasses, native trees, varieties of castor-oil beans and of cotton; soils—renovation with manures and leguminous plants, inoculation experiments; analyses of fertilizers and food materials; field and pot experiments—fertilizers, leguminous plants as soil renovators, barnyard manures, cereals, cotton, forage crops; horticulture—varieties of strawberries and other fruits and asparagus, irrigation of garden vegetables; plant breeding—cotton, cowpeas; diseases of plants; feeding and pasturing experiments with beef and dairy animals and hogs; diseases of animals; dairying—milk, butter, and cheese production.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Fees for the analysis of fertilizers | 11,202.41 |
| Farm products | 409.63 |
| Miscellaneous | 859.40 |
| Total | 27,441.44 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 125, some diseases of cattle; 126, a leaf-curl disease of oaks; 127, alfalfa in Alabama; and the Annual Report of the station for 1903. The bulletin on the leaf-curl disease of oaks contains also notes on native oaks useful as shade trees in Alabama.

## **Canebrake Agricultural Experiment Station,** *Uniontown.*

### GOVERNING BOARD.

Board of Control: R. R. Poole (*Commissioner of Agriculture, ex officio*), *Montgomery;* J. Huggins, *Newbern;* W. H. Taylor, *Uniontown;* G. D. Stollenwerck, *Uniontown;* Wm. Munford (*Treasurer*), *Uniontown;* J. B. Garber, *Laneville.*

### STATION STAFF.

J. F. Duggar, M. S., *Director.* J. M. Richeson, M. S., *Assistant Director, Secretary.* J. F. Connor, V. M. D., *Veterinarian.*

### GENERAL OUTLOOK.

The Canebrake Station has continued to devote its attention largely to field experiments for the reclamation and improvement of worn-out soils. These have included experiments with a large number of forage crops, fertilizer and cultural experiments, variety tests with cotton and corn, and experiments with wheat and oats. Considerable attention has been given during the past year to subsoiling for all crops.

### LINES OF WORK.

The principal lines of work conducted at the Canebrake Station during the past year were as follows: Soil improvement, field experiments, horticulture, floriculture, diseases of plants, and diseases of animals.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| State appropriation | $2, 500. 00 |
| Farm products | 800. 00 |
| Total | 3, 300. 00 |

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 19–21. Bulletin 19 is a report of tests of oats and wheat at Uniontown in 1903. Bulletin 20 gives an account of results obtained in the culture of alfalfa, soy beans, cowpeas, melilotus, hairy vetch, crimson clover, sorghum, barley, millet, teosinte, German millet, rape, and other forage crops at Uniontown, and Bulletin 21 is a report on experiments with cotton and corn.

## **Tuskegee Agricultural Experiment Station,** *Tuskegee Institute.*

Department of the Tuskegee Normal and Industrial Institute.

### GOVERNING BOARD.

Board of Trustees: Chas. C. Thach * (*President*), *Auburn;* R. R. Poole * (*Commissioner of Agriculture*), *Montgomery;* Geo. W. Campbell,* *Tuskegee Institute;* R. C. Bedford (*Secretary*), *Beloit, Wis.;* Warren Logan * (*Treasurer*), *Tuskegee Institute;* Lewis Adams,* *Tuskegee Institute;* Chas. W. Hare,* *Tuskegee Institute;* Booker T. Washington,* *Tuskegee Institute;* J. W. Adams, *Montgomery;* John C. Grant, *Chicago, Ill.;* Geo. A. Gordon, *Boston, Mass.;* Chas. F. Dole, *Boston, Mass.;* J. G. Phelps Stokes, *New York City;* Wm. H. Baldwin, jr., *New York City;* R. O. Simpson, *Furman;* Robt. C. Ogden, *New York City;* George Foster Peabody, *New York City;* Hugh H. Hanna, *Indianapolis, Ind.;* Paul M. Warburg, *New York City.*

### STATION STAFF.

G. W. Carver, M. Agr., *Director.*
P. C. Parks, *Superintendent of Farm.*
C. E. Greene, *Practical Agriculturist, Home Farm.*
Geo. R. Bridgeforth, B. S., *Stock Raising.*
G. W. Owens, *Dairyman.*
G. K. Gordon, *Dairyman.*
A. F. Crawford, *Landscape Gardener.*
D. A. Williston, B. S. A., *Landscape Gardener.*
C. J. Calloway, *Bureau of Nature Study.*
J. B. Brown, *Truck Gardening.*

### GENERAL OUTLOOK.

The investigations of the Tuskegee Station have been similar in character to those of the previous year, with the addition of the study of fall and winter cover crops. Among the crops being tested for these purposes are different varieties of oats and wheat, home-grown rye, barley, crimson clover, and vetches. The station is cooperating with a number of farmers in the State in growing rice and Cuban sugar cane from seed and cuttings distributed by the station.

### LINES OF WORK.

The principal lines of work conducted at the Tuskegee Station during the past year were as follows: Field experiments, horticulture, diseases of plants, animal industry, and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| State appropriation | $1,500 |

### PUBLICATIONS.

Bulletin 5 on cowpeas, in which a discussion is given of the value of cowpeas as a fertilizer and as human food.

## ALASKA.

### **Alaska Agricultural Experiment Stations,** *Sitka, Kenai, Copper Center,* **and** *Rampart.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

### STATION STAFF.

C. C. Georgeson, M. S., *Special Agent in Charge, Sitka.*

F. E. Rader, B. S., *Assistant at Rampart.*

R. W. De Armond, *Assistant at Sitka.*

P. H. Ross, B. S., *Assistant at Kenai.*

J. W. Neal, *Assistant at Copper Center.*

### GENERAL OUTLOOK.

During the past year experiment stations were maintained at Sitka, Kenai, Rampart, and Copper Center, and cooperative experiments were conducted at Wood Island. Seeds of vegetables and flowers were distributed through the cooperation of the Bureau of Plant Industry to about 1,500 addresses. Many of the recipients report success and further confirm the possibility of raising hardy vegetables and hardy annual flowers in nearly all parts of the Territory south of the Arctic Circle. An investigation of the grasses and forage plants of Alaska is being conducted in connection with the Bureau of Plant Industry.

At Sitka the headquarters building has been completed in accordance with the plans furnished by this Department, except for some minor alterations made in the interests of economy. More attention will hereafter be given at this station to horticulture and the propagation of trees and bushes for distribution to the other stations and over the Territory at large. Some nursery stock, consisting of hardy and early maturing varieties of apples, plums, and cherries, has been planted, and currants, gooseberries, and raspberries are also being propagated. Three thousand apple seedlings raised from selected hardy varieties were obtained from the Minnesota Experiment Station last spring.

At the Kenai Station about 21 acres have been brought under cultivation. Experience during the past two seasons at this point has shown that the maturing of grain is somewhat uncertain, though an abundance of forage can be grown every year. Cattle do well here, and the station is beginning in a small way to build up a herd. H. P. Neilson, who has been in charge of this station since its beginning in the spring of 1899, resigned November 1, 1903, and has been succeeded by Mr. P. H. Ross, a graduate of the Kansas Agricultural College.

At the Copper River Valley Station, opened two years ago, a number of acres have been cleared and cultivated. During the season of 1903 barley and oats matured, and produced plump and heavy grain. Cultivated grasses seeded in experimental plats did well, and a considerable variety of hardy vegetables were grown. In 1904 an elaborate system of plats was laid out and extensive experiments are under way with cereals. During August a severe frost destroyed many varieties of the cereals, rendering them fit only for hay, but some barley was matured and the grain saved for seed, and about 90 per cent of the Sixty Day and Finnish Black oats were matured, making about an average crop. This station has the first equipment of farm implements brought into the interior of Alaska. A number of small tracts have been cleared by settlers and are under cultivation at various points throughout the valley.

Only a small amount of work was done at the Rampart Station during the past year. Grain matured as it did the year before, and this has encouraged us to undertake more extensive experiments. An equipment of implements has been procured, and F. E. Rader, who has been assistant at the Sitka Station since the spring of 1900, has taken charge of the work.

The cooperative work on Wood Island is being continued. It is confined, however, to the growing of vegetables and testing of grains and grasses. Thus far grains have not matured well, but it is proved that they can be grown so as to yield an abundance of cattle feed. These experiments cost the station but little aside from the seed which is furnished.

In general the experimental work in Alaska has shown that live stock may be successfully maintained at many points in the Territory. The special agent in charge of the Alaska stations urges the desirability of securing breeds of sheep and cattle better adapted to the climate of Alaska than those which have hitherto been maintained there. It is, however, impracticable to carry on experiments with animals in any large way with the present funds at the disposal of the stations.

### LINES OF WORK.

The principal lines of work conducted at the Alaska stations during the past fiscal year were as follows: Field experiments with cereals, fiber plants, vegetables, and grasses; tests of methods of reclamation, drainage, and fertilization of land; curing and ensiling of forage crops; horticulture—propagating currant, gooseberry, and raspberry plants, experiments with hardy fruit trees, ornamentals, and strawberries; animal husbandry, and meteorological observations.

### INCOME.

The income of the stations during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 153.10 |
| Total | 15,153.10 |

### PUBLICATIONS.

The eighth report on the investigations in Alaska, giving a detailed account of the operations during the year 1904, has been prepared by the special agent in charge of Alaska investigations, and is given on page 265.

## ARIZONA.

### **Agricultural Experiment Station of the University of Arizona,** *Tucson.*

Department of the University of Arizona.

#### GOVERNING BOARD.

Board of Regents: Winfield Scott (*Chancellor*), *Scottsdale;* George J. Roskruge (*Secretary*), *Tucson;* J. M. Ormsby (*Treasurer*), *Tucson;* Charles S. Bayless, *Tucson;* Governor A. O. Brodie (*ex officio*), *Phoenix;* N. G. Layton (*Superintendent of Public Instruction, ex officio*), *Phoenix.*

#### STATION STAFF.

R. H. Forbes, M. S., *Director; Chemist.*
Vinton A. Clark, M. S., (*Phoenix*), *Agriculturist, Horticulturist.*
J. J. Thornber, A. M., *Botanist.*
Henry B. Slade, *Associate Chemist.*
T. D. A. Cockerell (*Boulder, Colo.*), *Consulting Entomologist.*
J. W. Lewis, *Clerk.*

#### GENERAL OUTLOOK.

Few changes have been made during the past fiscal year in the work of the Arizona Station. Prominence has been given as heretofore to range improvement, animal husbandry, the introduction of new crops, and irrigation investigations with special reference to the water supply of the Territory. The irrigation investigations are conducted in cooperation with this Office and the studies on the water supply of the Colorado River in cooperation with the United States Geological Survey. Incidental to the latter is a study of agricultural conditions along the Colorado River and tests of berseem on the overflow lands of the Colorado River near Yuma in cooperation with the Bureau of Plant Industry of this Department. The station is also cooperating with the Bureau of Plant Industry in drug plant investigations and with the Bureau of Soils in the reclamation of alkali lands. One of the most important crop introductions is that of date palms in cooperation with the Bureau of Plant Industry, and now that these are coming into bearing an opportunity is afforded to study means of artificially hastening the ripening of dates.

In the animal-husbandry work emphasis is laid on dairying and feeding, the latter to find suitable carbohydrates to combine with alfalfa. Some feeding experiments with hogs have also been made, and the possibility of utilizing hogs to eradicate Johnson grass is being tested. Extensive comparative tests are being made with native and introduced alfalfa, grasses, and other forage plants, both at Tucson and Phoenix. There is a general demand among farmers in the Territory for a grass to feed or graze in connection with alfalfa. Thus far none of the introduced species has proved superior to the native kinds. The study of the relation of climate to crops, which has been continued at the Arizona Station for six years, has now been closed and the results published. The results of the director's investigations with honey have been published in Timely Hints for Farmers.

The appropriation of $11,000 for the station made by the last legislature has become available recently and will be used in part for improving the farm equipment and buildings at Phoenix. There is also a Territorial appropriation of $2,300 for farmers' institutes which are now being developed. No changes of importance occurred in the staff of the station during the fiscal year, but since the close of the year the animal husbandman and the agriculturist and horticulturist have resigned. The latter has been succeeded by V. A. Clark, late of the New York State Station. H. B. Slade has succeeded the associate chemist.

The station is apparently making a success of the date-palm introduction and has made considerable progress in demonstrating the possibilities of improving range conditions and discovering forage plants suited to the ranges. This work is well organized and efficiently managed, and good use is being made of the funds available for investigation.

### LINES OF WORK.

The principal lines of work conducted at the Arizona Station during the past year were as follows: Chemistry—study of irrigation waters and their effects upon irrigated soils; botany; field experiments—cereals and forage crops; irrigation investigations; improvement of ranges; horticulture—date-palm growing, vegetables, fruits, etc.; dairying and feeding experiments—beef and dairy cattle, sheep and hogs.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 313.39 |
| Fees | 20.90 |
| Farm products | 528.48 |
| Miscellaneous, including balance from previous year | 381.58 |
| Total | 16,244.35 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 46, on the underground waters of Arizona, their character and uses; Bulletin 47, timely hints for farmers; Index Bulletin, containing indexes to Volume III, Bulletins 33–40, and Annual Reports for 1900 and 1901, and the Annual Report for 1903. The latter contains brief administrative reports and summaries of the operations and investigations in the different departments of the stations.

## ARKANSAS.

### **Arkansas Agricultural Experiment Station,** *Fayetteville.*

Department of the University of Arkansas.

#### GOVERNING BOARD.

Board of Trustees: Governor Jefferson Davis (*ex officio President,*) *Little Rock;* H. F. Reagan (*Secretary*), *Fayetteville;* Otey Miller (*Treasurer*), *Fayetteville;* G. T. Breckinridge, *Paragould;* W. H. Langford, *Pine Bluff;* C. C. Hamby, *Prescott;* H. L. Stroup, *Paris;* J. C. Mitchell, *Fayetteville;* J. C. South, *Mountain Home.*

## STATION STAFF.

W. G. Vincenheller, *Director.*
R. R. Dinwiddie, V. S., M. D., *Pathologist, Bacteriologist.*
Ernest Walker, B. S. A., *Horticulturist, Entomologist.*
G. A. Cole, M. A., *Agriculturist.*
J. H. Norton, B. S., *Chemist.*
V. A. Hooper, *Dairyman, Animal Husbandman.*

## GENERAL OUTLOOK.

The work of the Arkansas Station has been continued along the lines laid down in previous reports, with the addition of some investigations in rice growing and in flax culture. The investigations on pork production have been continued, and the value of cowpeas and cotton-seed products as feeding stuffs has been studied. The poisonous effect of cotton-seed meal when fed to pigs is still under investigation, the object being to establish the rate at which cotton-seed meal may be safely fed to hogs. Relatively small quantities of meal are fed; the animals are slaughtered, and an examination made of the livers and kidneys, these organs seeming to be the ones most visibly affected. Feeding cotton-seed oil at the rate of one-fourth of a pound per day with sufficient wheat bran to render the mixture palatable is being carried on to determine whether the poisonous principle of the seed is also found in the oil. It appears that the toxic principle of cotton-seed products is apparently confined to the kernels or meat, and is wholly absent from the oil and hulls. The economy of feeding cotton-seed meal as an adjunct to a corn ration in all stages of pig growth is still under investigation. The effect of feeding cotton-seed oil on the melting point of lard is being investigated, as well as its effect upon the meat produced. The cowpea studies mentioned in a previous report are being continued, the departments of agriculture and chemistry cooperating in this work. About 80 varieties of cowpeas are now under observation, the peas, vines, and hay all being studied. Breeding experiments with cowpeas are now being carried on, and attempts are being made to correlate the feeding results already obtained with the peas, with the vines, and with the hay. Attempts are being made to produce varieties of cowpeas adapted to harvesting by machinery, and some strains have been under observation for five years, many of them coming quite true to seed. The investigations on asparagus culture have been completed, and it is shown that asparagus may be readily grown in the State and that it offers a profitable line of horticultural investment. The application of common salt by preventing weed growth is said to greatly benefit the asparagus crop. Studies of fungicides and insecticides are being made, and so far liquid spraying has given better results than where a dust spray has been used. Carbon bisulphid has been found a satisfactory treatment for peach borers and the round-headed apple-borer, and studies are being made of means for the repression of the grape leaf hopper.

The station has been cooperating with the Bureau of Plant Industry of this Department in corn breeding and culture, soy-bean investigations, and the testing of a large number of varieties of apples, and with this Office in growing rice under irrigation. The State legislature at its last session appropriated $1,000 for veterinary inspection work and for the manufacture of blackleg virus and its distribution. The increasing popularity of the station is attested by the continued demands for its publications. The editions of the station bulletins have been increased to 14,000 during the year, and the demand is such that 20,000 bulletins could be used. The deficiency will be met by reprinting those for which there is the greatest demand. An attempt is being made with considerable success to develop and extend the farmers' institutes, which are attended by members of the station staff. It is confidently hoped that the State will aid in this extension work. The station is greatly in need of additional funds for buildings, assistants, equipment, etc., in order to increase its usefulness in the departments of agriculture, horticulture, and chemistry. A demand is being made on the station to take up the consideration of some of the problems of animal husbandry, especially those in relation to dairying, and this will be done when funds are provided.

### LINES OF WORK.

The principal lines of work conducted at the Arkansas Station during the past year were as follows: Chemistry—adulteration of foods, cowpea analyses, analyses of Paris green, effect of feeding cotton-seed meal, and the effect of cotton-seed oil on the melting point of lard; field experiments—rotation of crops, testing and breeding cowpeas, corn culture, spring and fall sowing of alfalfa, soy beans, peanuts, and other forage plant studies, broom corn, rice, etc.; horticultural investigations—testing varieties of apples, peaches, small fruits and vegetables, asparagus culture, and plant diseases; entomology—injurious insects and means for their repression, and inspection work; veterinary investigations—animal diseases, poisonous properties of cotton-seed products, preparation and distribution of blackleg vaccine, inspection work, etc.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $14,999.67 |
| Farm products | 863.83 |
| Total | 15,863.50 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 76–82, and the Annual Report for 1902, the latter containing reprints of bulletins issued during the year. The subjects of the bulletins are cowpea experiments, pig-feeding experiments with cotton-seed meal, the relative digestibility of some edible fats and oils, peach growing in Arkansas, cowpea hay, fertilizers, and live-stock sanitation in Arkansas.

## CALIFORNIA.

### Agricultural Experiment Station of the University of California, *Berkeley*.

Department of the University of California.

### GOVERNING BOARD.

The Regents of the University: Governor G. C. Pardee (*ex officio President*), *Sacramento;* Alden Anderson,* *2 Morgan st., Suisun City;* T. J. Kirk (*State Superintendent of Public Instruction*), *Sacramento;* Benj. F. Rush, *Suisun City;* R. J. Taussig, *26 Main st., San Francisco;* Benjamin Ide Wheeler, *1820 Scenic ave., Berkeley;* Isaias W. Hellman, *Nevada Bank, San Francisco;* Chester Rowell,* *Fresno;* J. A. Waymire, *Alameda;* C. W. Slack, *Nevada Block, San Francisco;* J. B. Reinstein, *217 Sansome st., San Francisco;* J. E. Budd,* *Stockton;* Mrs. Phœbe A. Hearst, *Pleasanton;* A. W. Foster, *Mutual Life Building, San Francisco;* Garret W. McEnerney, *Nevada Block, San Francisco;* C. N. Ellinwood, *2739 Pacific ave., San Francisco;* C. S. Wheeler, *532 Market st., San Francisco;* G. C. Earl, *2739 Pacific ave., San Francisco;* J. W. McKinley, *25¼ South Broadway, Los Angeles;* Rev. P. C. York, *1267 Sixteenth ave., Oakland;* J. A. Britton, *600 Rialto Building, San Francisco;* F. W. Dohrmann, *12¼ Sutter st., San Francisco.*

### STATION STAFF.

E. W. Hilgard, Ph. D., LL. D., *Director; Chemist.*
E. J. Wickson, A. M., *Horticulturist.*
W. A. Setchell, Ph. D., *Botanist.*
R. H. Loughridge, Ph. D., *Agricultural Geologist and Soil Physicist (Soils and Alkali).*
C. W. Woodworth, M. S., *Entomologist.*
Ralph E. Smith, B. S., *Plant Pathologist.*
Elwood Mead, M. S., C. E., D. E., *Irrigation Engineer.*
M. E. Jaffa, M. S., *Assistant Chemist (Foods and Nutrition).*
George Roberts, M. S., *Chemist (Fertilizer Control).*
G. W. Shaw, A. M., Ph. D., *Assistant Chemist (Sugar, Starches, Oils).*
George E. Colby, M. S., *Assistant Chemist (Fruits, Waters, and Insecticides).*
H. M. Hall, M. S., *Assistant Botanist.*
F. T. Bioletti, M. S., *Viticulturist.*
A. R. Ward, B. S. A., D. V. M., *Veterinarian, Bacteriologist.*
E. W. Major, B. Agr., *Animal Industry.*
Henry J. Quayle, A. B., *Assistant in Entomology.*

C. A. Triebel, PH. G., *Student Assistant in Agricultural Laboratory.*

C. M. Haring, D. V. M., *Assistant Veterinarian, Bacteriologist.*

W. T. Clarke, B. S., *Assistant Superintendent of University Extension.*

A. V. Stubenrauch, M. S. A., *Assistant Horticulturist; in charge of Substations.*

S. Fortier, M. E., *Irrigation.*

A. P. Stover, B. S., *Assistant in Irrigation.*

R. E. Mansell, *Foreman of Grounds.*

C. A. Colmore, B. S., *Clerk to Director.*

W. H. Volck, *Temporary Assistant Entomologist.*

### OUTLYING STATIONS.

San Joaquin Valley Station: John Tuohy, *Patron, Tulare;* Julius Forrer, *Foreman, Tulare.*

Southern California Station: J. E. McComas, *Patron, Pomona;* James W. Mills, *Superintendent, Pomona;* J. H. Barber, *Assistant Superintendent, Ontario.*

Chico Forestry Station: J. W. Roper, *Patron, Chico;* Henry Wightman, *Workman in Charge.*

Santa Monica Forestry Station: Roy Jones, *Patron, Santa Monica;* William Shutt, *Foreman, Santa Monica.*

Poultry Experiment Station: H. O. Woodworth, M. S., *Foreman, Petaluma.*

Mecca Date Garden, *Mecca* (conducted in cooperation with the U. S. Department of Agriculture), Barnard G. Johnson, *Workman, Mecca.*

### GENERAL OUTLOOK.

The main lines of work of the California Station have remained the same as in previous years. There has been considerable development of cooperative work and of local investigations provided for by private donations and special State appropriations, including dairying, poultry experiments, plant pathology, viticulture, and fertilizer inspection.

The Watsonville Orchard Association has provided funds for the continuation of the codling-moth investigation, which was begun last year by the entomologist and his assistants, with the cooperation of the association. The San Rafael Improvement Club has inaugurated a campaign of extermination against the mosquito pest, under the direction of the station entomologist. There is also a large amount of cooperation with this Department—with the Bureau of Plant Industry in fiber and viticultural investigations, establishing a testing and propagating garden for new productions, buying seeds and plants for testing, and date investigations, ultimately designed to include opuntias, grapes, olives, and other desert-loving plants; with the Bureau of Chemistry in the effect of environment on the chemical composition of sugar beets, and with this Office in nutrition and irrigation investigations. Some additions to equipment have been made during the year, including a poultry plant on the 5-acre tract set apart for the poultry investigations at Petaluma, consisting of a foreman's cottage, brooder house, hospital, and other poultry buildings, and additions to the equipment of the dairy farm. An entomological building to cost $5,000 has been planned. The substations at Tulare, Pomona, Chico, and Santa Monica have been continued. At Pomona considerable new work involving original investigation has been started. This includes a study of the behavior of oranges on four different kinds of stocks and under irrigation to different depths, experiments on the growth of sugar-beet seed under the control of the chemist of the Berkeley station, and studies of evaporation and water requirements of plants on different kinds of soil. The work of this substation has been greatly facilitated by the improved water supply from wells.

As stated in the last report of this Office, the great need of the California Station is for a liberal State appropriation which will be more permanent and less restricted than the irregular appropriations and donations which are now available. There is urgent need of funds for the construction of a new agricultural building for the college and station, for the purchase and equipment of a farm, and for the aid of agricultural investigation. It is hoped that the strong movement now on foot to secure such an appropriation from the legislature will be successful.

### LINES OF WORK.

The principal lines of work conducted at the California Station during the past year were as follows: Chemistry—foods, feeding stuffs, fertilizers, fruits, and insecticides; physics, chemistry, and geographical distribution of soils; bacteriology; fertilizer control; field crops; horticulture, including date culture, viticulture, and zymology; sylviculture; botany; meteorology; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; plant and animal pathology; nutrition investigations, and poultry experiments.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 6,139.91 |
| Farm products | 1,624.06 |
| Miscellaneous | [a]10,000.00 |
| Total | 32,763.97 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

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[a] Portion spent for agricultural research of fund of $29,584.39 for salaries and running expenses of the department of agriculture.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 147 and 149–156 and the Biennial Report for 1901–1903. The subjects of the bulletins were as follows: Culture work at the substations, 1899–1901; the California sugar industry, Part 1—historical and general; the value of oak leaves for forage; arsenical insecticides; fumigation dosage; spraying with distillates; sulphur sprays for red spiders; directions for spraying for the codling moth, and fowl cholera. The Biennial Report includes a financial statement; a summary of bulletins issued during the year; lists of donations to the station, and newspapers and periodicals received; reports on the work in the different departments of the station and at the substations; and articles on the following subjects: Farmers' institutes; soils; alkali and alkali lands; drainage of Fresno district; examinations of waters, foods, feeding stuffs, fruits, etc.; investigations in dairying; distribution of seeds, plants, etc., and meteorological observations. There were also received circulars on the new fertilizer law, Texas fever, blackleg, hog cholera, anthrax, contagious abortion in cows, methods of physical and chemical soil analysis, remedies for insects, laboratory for ordinary chemical examination of waters for irrigation and domestic purposes, reading course in economic entomology, and fumigation practice.

## COLORADO.

### **Agricultural Experiment Station**, *Fort Collins.*

Department of the State Agricultural College of Colorado.

### GOVERNING BOARD.

The State Board of Agriculture: P. F. Sharp (*President*), *Denver;* A. M. Hawley (*Secretary*), *Fort Collins;* Whitney Newton (*State Treasurer*), *Denver;* Geo. A. Webb (*Local Treasurer*), *Fort Collins;* B. F. Rockafellow, *Canyon City;* Mrs. E. F. Routt, *Denver;* Jesse Harris, *Fort Collins;* Harlan Thomas, *Denver;* J. L. Chatfield, *Gypsum;* B. U. Dye, *Rockyford;* E. H. Grubb, *Carbondale;* Governor J. H. Peabody (*ex officio*), *Denver;* B. O. Aylesworth (*ex officio*), *Fort Collins.*

### STATION STAFF.

L. G. Carpenter,[a] M. S., *Director; Irrigation Engineer.*
C. P. Gillette, M. S., *Entomologist.*
W. P. Headden, A. M., Ph. *D., Chemist.*
Wendell Paddock, M. S., *Botanist; Horticulturist.*
B. O. Longyear, B. S., *Botanist.*
G. H. Glover, M. S., D. V. M., *Veterinarian.*
W. L. Carlyle, B. S. A., *Animal Husbandman.*
A. H. Danielson, B. S., *Agronomist.*
A. M. Hawley, *Secretary.*
Margaret Murray, *Clerk; Stenographer.*
F. C. Alford, M. S., *Assistant Chemist.*
E. Douglass, M. S., *Assistant Chemist.*
R. E. Trimble, B. S., *Assistant Meteorologist; Irrigation Engineer.*
S. A. Johnson, M. S., *Assistant Entomologist.*
P. K. Blinn, B. S., *Field Agent, Arkansas Valley Substation, Rockyford.*

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[a] On leave.

## GENERAL OUTLOOK.

There has been no change of importance in the work of the Colorado Station during the past year. The irrigation investigations, feeding experiments with alfalfa and by-products of sugar beets, and horticultural investigations have been continued and some work in animal husbandry has been developed, especially along the line of horse breeding. This work and the feeding experiments are conducted in cooperation with the Bureau of Animal Industry of this Department; the irrigation work in cooperation with this Office; drug plant investigations with the Bureau of Plant Industry, and studies on the effect of environment on the chemical composition of sugar beets with the Bureau of Chemistry. The chemist has published two bulletins as a result of his study of the irrigation waters of the State, and is preparing for publication data on the digestibility of coarse fodders. The work of the horticulturist has been confined largely to studies of plant diseases—blights of potatoes, melons, apples, pears, and blackberries, and the development of disease-resistant varieties of these crops.

A new horse barn has been completed, and a farm of 73 acres a short distance east of the college has been purchased by the college to be used in connection with the investigations in agronomy and animal husbandry. The 360-acre tract of dry land with a spring and reservoir site, which was acquired recently by the college, is used for grazing purposes and for a test of the natural reseeding of buffalo grass. It is the purpose ultimately to reclaim at least a part of this tract by irrigation. The engineering building has not been constructed because there were no funds available for the $40,000 appropriation made by the legislature. The field work in eastern Colorado has been temporarily abandoned, but that in the Arkansas Valley is continued, together with some experimental work at the former substation on disease-resistant melons, improvement of melons by seed selection, early ripening varieties of wheat, and other similar work.

The Colorado Station has in hand considerable work directly related to the agricultural interests of the State, and is gradually acquiring a good equipment for experimental inquiries. Its funds, however, are so limited that after providing for salaries and the other administrative expenses very little is left to meet the expenses of the investigations. Under present conditions it seems very desirable that the administration work should be further concentrated and the investigations confined to a few lines which can be vigorously prosecuted and promptly reported.

## LINES OF WORK.

The principal lines of work conducted at the Colorado Station during the past year were as follows: Chemistry—analysis of soils and irrigation waters, sugar-beet investigations, studies of methods of analyzing feeding stuffs, etc.; entomology; field experiments—variety tests of wheat and oats for different altitudes; horticulture; diseases of plants; animal husbandry—breeding and feeding experiments; entomology—study of the codling moth, grasshoppers, various borers and leaf rollers, cutworms, and insects working on sugar beets and cantaloupes; irrigation—use of water, measurements of losses from ditches, studies of means for economizing water, measurements of seepage on the Platte, the Arkansas, the Rio Grande, and their tributaries.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Miscellaneous | 1,313.59 |
| Total | 16,313.59 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 82–86, on Colorado irrigation waters and their changes, irrigation waters and their effects, an apricot blight, cantaloupe seed, and crown gall.

## CONNECTICUT.

### The Connecticut Agricultural Experiment Station, *New Haven.*

#### GOVERNING BOARD.

State Board of Control: Governor Abiram Chamberlain (*President*), *Hartford;* W. H. Brewer (*Secretary*), *New Haven;* E. H. Jenkins (*Treasurer*), *New Haven;* W. O. Atwater, *Middletown;* Edwin Hoyt, *New Canaan;* J. H. Webb, *Box 1425, New Haven;* T. S. Gold, *West Cornwall;* B. W. Collins, *Meriden.*

#### STATION STAFF.

E. H. Jenkins, PH. D., *Director.*
A. L. Winton, PH. D., *Chemist.*
T. B. Osborne, PH. D., *Chemist.*
I. F. Harris, M. S., *Chemist.*
E. Monroe Bailey, PH. B., *Chemist.*
I. A. Andrew, PH. B., *Chemist.*
Kate G. Barber, B. S., *Chemist.*
W. E. Britton, PH. D., *Entomologist.*
Walter Mulford,[a] F. E., *in charge of Forest Work, and State Forester.*
Austin F. Hawes, M. F., *Assistant Forester.*
G. P. Clinton, S. D., *Botanist.*
V. E. Cole, *Librarian, Clerk.*
William Veitch, *in charge of Buildings and Grounds.*
Hugo Lange, *Laboratory Assistant.*
J. B. Olcott, *Grass Garden (South Manchester).*
L. M. Brautlecht, *Assistant Clerk.*
V. L. Churchill, *Sampling Agent.*

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[a] On leave.

### GENERAL OUTLOOK.

The work of the Connecticut State Station has been continued as heretofore, and has included inspection of fertilizers, foods, feeding stuffs, orchard and nursery stock, and dairy apparatus, with studies of methods incident to this work; investigations of vegetable proteids; microscopy of food adulteration, and studies incident to the establishment of food standards; utilization of waste lands by forest planting; growing tobacco under shade, including improvement of varieties and studies of methods of handling and fermenting the products, and experiments with fertilizers for orchards. In the course of his studies on the castor bean, Doctor Osborne has prepared a large quantity of ricin, an extremely poisonous body, showing all the properties of a proteid. He has also been making a study of the decomposition products of the proteids of the wheat kernel, and has been aided in this work by a grant from the Carnegie Institution. The botanist of the station has finished an extended monograph on smuts. The entomologist has made spraying experiments and studies of the San José scale and other insects, and has undertaken a mosquito survey of the State. The salt marshes of the coast from the New York State line to Rhode Island and some of the breeding places of mosquitoes in the vicinity of Hartford, Middletown, and Cheshire have already been examined and mapped. The forester and his assistant have nearly completed the experimental plantings on the Lockwood Field, besides doing considerable other forestry work. They have recently issued a leaflet offering assistance to Connecticut farmers in the way of consultation and advice regarding the planting of waste areas. The forester is on leave of absence for study abroad, and Austin F. Hawes has been appointed assistant to serve in his absence. Dr. A. W. Ogden has recently resigned to accept a position in the Bureau of Chemistry, of this Department, in New York City.

This station is doing an increasing amount of work, not only in connection with its inspection duties, but also in the investigation of agricultural problems requiring long and careful scientific studies. Through its forestry work and its experiments in different parts of the State with tobacco and the spraying for insects, and in various other ways, it is coming into closer contact with the people of the State and aiding them in solving the problems they encounter.

### LINES OF WORK.

The principal lines of work conducted at the Connecticut State Station during the past year were as follows: Analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; chemistry—study of vegetable proteids; diseases of plants; horticulture—fertilization of orchards and study of the anatomy of fruits; forestry; field experiments—tobacco, grasses for turf making and pasture, and entomology.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $7,500.00 |
| State appropriation | 15,500.00 |
| Individuals | 6,900.00 |
| Fees, including balance from previous year | 3,831.56 |
| Farm products | 28.00 |
| Miscellaneous, including balance from previous year | 1,002.08 |
| Total | 34,761.64 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 144, on fighting the San José scale insect in 1903; Bulletin 145, on commercial feeding stuffs in the Connecticut market; Parts III and IV of the Annual Report for 1902, the latter containing articles on commercial feeding stuffs, tests of the vitality of vegetable seeds, a fruit census of Connecticut, observations on the fertilization of peach orchards, experiments in growing tobacco of the Sumatra type under shade, studies on the vegetable proteids, and the second annual report of the forester; and the Annual Report for 1903. This report consists of five parts, as follows: Part I, fertilizers; Part II, eighth report on food products; Part III, third report of the entomologist; Part IV, report of the station botanist; and Part V, feeding stuffs, fertilizing orchards, seed tests, tobacco work, and index.

## **Storrs Agricultural Experiment Station,** ***Storrs.***[a]

Department of the Connecticut Agricultural College.

### GOVERNING BOARD.

Board of Trustees: Governor Abiram Chamberlain (*ex officio President*), *Hartford;* E. H. Jenkins (*ex officio Vice-President*), *New Haven;* George A. Hopson* (*Secretary*), *East Wallingford;* B. C. Patterson, *Torrington;* E. S. Henry, *Rockville;* George S. Palmer, *Norwich;* D. W. Patten, *North Haven;* A. C. Capen, *Willimantic;* A. J. Pierpont, *Waterbury;* L. J. Storrs, *Spring Hill.*

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[a] Telegraph address, *Storrs* via *Willimantic;* railroad station, express, and freight address, *Eagleville.*

## STATION STAFF.

L. A. Clinton, M. S., *Director.*
H. W. Conn, PH. D., *Supervisor of Dairy Bacteriology.*
W. O. Atwater, PH. D., *Supervisor of Nutrition Work.*
A. G. Gulley, M. S., *Horticulturist.*
C. L. Beach, B. S., *Dairy Husbandman.*
B. B. Turner, PH. D., *Chemist.*
W. A. Stocking, jr., M. S. A., *Assistant Bacteriologist.*
E. R. Bennett, B. S., *Assistant Horticulturist.*
H. L. Garrigus, B. AGR., *Assistant in Field Experiments.*
W. M. Esten, PH. B., *Laboratory Assistant.*
E. H. Lehnert, B. S., D. V. S., *Consulting Veterinarian.*
E. A. White, B. S., *Consulting Botanist.*
Chas. Thom, PH. D., *Cheese Expert, Mycologist.*
A. W. Bosworth, B. S., *Cheese Expert, Chemist.*
Theodore Issajeff, *Cheese Maker.*

## GENERAL OUTLOOK.

The work of the Connecticut Storrs Station is now being developed especially along the lines of dairying, poultry raising, and the management of worn soils. The dairy investigations are principally concerned with dairy bacteriology in relation to sanitary milk production and handling and the manufacture of soft cheese, the latter in cooperation with the Bureau of Animal Industry of this Department. In connection with the dairy investigations herd records have been kept and a study made of the relative efficiency of the digestible nutrients of different feeds. A mycologist and a chemist have been appointed in connection with the cheese investigations. The investigations on the food and nutrition of man have been continued as heretofore in cooperation with this Office and have been aided by a special appropriation from the State. These investigations are conducted at Middletown. There were also alfalfa investigations and variety tests of sweet corn and pole beans in cooperation with the Bureau of Plant Industry of this Department.

In the poultry work special attention has been given of late to squab raising. Problems in the management of worn-out soils have been undertaken, both in connection with experiments with cover crops and leguminous crops, including alfalfa grown in a cooperative way in many parts of the State, and with horticultural work. Alfalfa has been found unsuited to Connecticut conditions, and the investigations with it have been discontinued. The horticultural work has included also experiments in spraying for plant diseases, growing various crops under shade, and thinning fruit.

During the year the poultryman resigned, and a number of appointments were made to new positions on the staff. Dr. B. F. Koons, for many years president of the Storrs Agricultural School and later of the Connecticut Agricultural College, died December 17, 1903, at the age of 55 years. At the time of his death he was consulting entomologist of the station and professor of natural history in the college. He had been connected with the institution for over twenty years.

The station has been steadily adding to its equipment and organizing its work along a few important lines. It is thus enabled to make an excellent showing with the very limited funds at its command. There are many problems related to the specialized agricultural industries of the State which ought to be studied by the station, but can not be considered until more liberal funds are provided.

### LINES OF WORK.

The principal lines of work conducted at the Connecticut Storrs Station during the past year were as follows: Food and nutrition of man and animals; bacteriology of dairy products; field experiments—fertilizers, soil tests, cover crops, nitrogen experiments; horticulture; poultry experiments, and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $7,500.00 |
| State appropriation | 1,800.00 |
| Miscellaneous | 15.71 |
| Total | 9,315.71 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 26–30 and the Annual Report for 1903. The bulletins were on the following subjects: The relation of temperature to the keeping property of milk, poultry as food, dairy observations, records of a dairy herd for five years, and spraying notes for 1903. The Annual Report includes, in addition to a financial statement, summary accounts of the operations of the different departments of the station, and a description of the recently equipped bacteriology laboratory, the following special articles: Thinning fruit, comparison of bacteria in strained and unstrained samples of milk, strained and unstrained milk preserved at 70° and 50° F., aseptic milk, qualitative analysis of bacteria in market milk, bacteria in freshly drawn milk, the nutrition investigations of the Storrs Experiment Station, the conservation of energy in the living organism, the demands of the body for nourishment and dietary standards, the composition of poultry, poultry as food, dehorning cattle, milking records, food cost of raising calves, meteorological observations at Storrs, and general crop review.

## DELAWARE.

### The Delaware College Agricultural Experiment Station, *Newark*.

Department of Delaware College.

#### GOVERNING BOARD.

Board of Trustees: C. B. Lore (*President*), *Wilmington;* Manlove Hayes* (*Vice-President*), *Dover;* C. B. Evans* (*Secretary and Treasurer*), *Newark;* Governor John Hunn (*ex officio*), *Dover;* G. A. Harter* (*ex officio*), *Newark;* James Hossinger, *Newark;* H. G. M. Kollock, *Newark;* J. C. Higgins, *Delaware City;* G. W. Marshall, *Milford;* J. H. Whiteman, *Wilmington;* George Biddle, *Elkton;* F. W. Curtis, *Newark;* W. T. Lyman,* *Wilmington;* D. W. Corbit,* *Odessa;* Edward Reynolds, *Middletown;* L. H. Ball, *Marshalltown;* L. P. Bush, *Wilmington;* J. E. Addicks, *Claymont;* J. C. Stockly, *Smyrna;* James Pennewill, *Dover;* C. S. Conwell, *Camden;* Geo. G. Kerr,* *Newark;* H. W. Baker, *Seaford;* E. R. Paynter, *Georgetown;* W. H. Stevens, *Seaford;* John Barkley, *Clayton;* W. Watson Harrington, *Dover;* Lewis M. Mustard, *Lewes;* S. H. Messick, *Bridgeville.*

#### STATION STAFF.

Arthur T. Neale,* A. M., PH. D., *Director, Agriculturist.*
F. D. Chester, M. S., *Mycologist.*
C. P. Close, M. S., *Horticulturist.*
Clayton O. Smith, B. S., A. M., *Assistant Bacteriologist.*
C. L. Penny, A. M., *Chemist.*
C. O. Houghton, A. B., *Entomologist.*

#### GENERAL OUTLOOK.

There has been little change in the conditions or lines of work at the Delaware Station during the past fiscal year. The bacteriologist is continuing his studies of soil micro-organisms and has published a bulletin on the bacteriological analysis of soils; the chemist has made a study of cover crops as green manure and has been carrying on a soil survey of the State; the entomologist has been engaged upon a study of a number of important insects and their repression; and the horticulturist has been working upon the effect of the Cooper-Hewett mercury vapor lamp in the greenhouse. He has also been working on orchard cover crops in cooperation with the Bureau of Plant Industry of this Department, the pruning of peach trees, and a modification of the lime-sulphur-salt mixture.

The staff of the Delaware Station devotes its time almost exclusively to station work. The station has no farm, but field trials are conducted in cooperation with farmers or on a private farm near the station. On this farm there is now, in addition to field experiments, a quite important experiment in the production of sanitary milk on an economic basis. In this work very cheap, plain buildings are erected and use made of only those appliances for handling milk which any careful farmer might have, but at the same time all the provisions for hygienic conditions in the stable and in the handling of the milk are observed, and the milk is examined for germ content. It is a practical commercial problem on a strictly commercial basis, and the results should be of considerable value to farmers in the vicinity of large cities. The Delaware Station, as well as the agricultural department of the college, greatly needs additional funds for adequate equipment and extension of work.

### LINES OF WORK.

The principal lines of work conducted at the Delaware Station during the past year were as follows: Chemistry; bacteriology—studies of nitrifying bacteria and nitrogen-assimilating bacteria; field experiments—cultural experiments with legumes and other forage and field crops, breeding experiments with cereals; horticulture—study of cover crops for orchards, pruning of orchards, varieties of fruits; diseases of plants—study of blights and other diseases of cantaloupes, canker of pears and apples, asparagus rust and other fungus diseases of fruits and vegetables; feeding experiments; diseases of animals; entomology—studies of insects attacking fruit and shade trees, and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 60–65, on cover crops as green manure, orchard cover crops in Delaware, pruning the peach, notes on fungus diseases in Delaware, some experiences with lime, sulphur, and salt washes, and the bacteriological analysis of soils; and the Annual Report for 1902, in which the following topics are treated: Dairying as a factor in the profitable utilization of farm lands; studies in plant diseases, including treatment of pear canker or body blight, pear blight notes, a blight of currants, a blight of Japanese chestnuts and of peach stock, and spraying tomatoes for blight; studies of soil bacteriology; report of the chemist, including the growth of crimson clover, sugar-beet experiment, insecticides, and changes in the composition of growing peaches; report of the horticulturist, including nitrate of soda on asparagus, thinning apples, peach thinning experiments, plant nutrition as applied to peaches, pear self-pollination, peach self-pollination, apple pollinations, root forcing on fruit trees, orchard cover crops, and the station orchard; report of the entomologist, including remedies for the codling moth, remedies for apple plant lice, remedies for the San José scale, remedies for the strawberry root louse, the periodical cicada, the harlequin cabbage bug, the white-marked tussock moth, and the fall webworm; and report of the meteorologist.

## FLORIDA.

### **Agricultural Experiment Station of Florida,** *Lake City.*

Department of University of Florida.

#### GOVERNING BOARD.

Board of Trustees: George W. Wilson (*President*), *Jacksonville;* F. E. Harris, *Ocala;* F. L. Stringer (*Secretary*), *Brooksville;* E. D. Beggs, *Pensacola;* C. A. Carson (*Vice-President*), *Kissimmee;* F. M. Simonton, *Tampa;* J. R. Parrott, *Jacksonville;* W. P. Jernigan (*Clerk*), *Lake City.*

#### STATION STAFF.

Andrew Sledd, A. M., PH. D., *Director.*
C. M. Conner, B. S., *Vice-Director, Agriculturist.*
E. R. Flint, B. S., PH. D., M. D., *Chemist.*
E. H. Sellards, M. A., PH. D., *Entomologist, Geologist.*
F. M. Rolfs, M. S., *Botanist, Horticulturist.*
C. F. Dawson, M. D., D. V. S., *Veterinarian.*
A. W. Blair, M. S., A. M., *Assistant Chemist.*
A. Tyler, *Stenographer, Librarian.*
F. C. Reimer, B. S., *Assistant Botanist and Horticulturist.*
R. A. Lichtenthaeler, M. S., *Assistant Chemist.*
S. A. Robert, B. S., *Assistant in Field Experiments.*
John F. Mitchell, *Foreman of Farm.*
J. H. Jefferies, *Foreman of Gardens and Orchards.*
W. P. Jernigan, *Auditor, Bookkeeper.*

#### GENERAL OUTLOOK.

The investigations of the Florida Station have not been changed materially during the past year. The experiments with varieties of pineapples and pecans have been suspended temporarily, but the other work has gone on as formerly. During the year the agriculturist conducted feeding experiments with horses and mules to determine whether home-grown feeding stuffs (sweet potatoes and cassava) could be profitably substituted for corn and oats, and obtained results which indicate that these products may be so used, and with some saving in the cost of feeding. In these experiments beggar-weed hay was used as the source of protein supply. There have also been feeding and digestion experiments with steers to compare the feeding value of sweet potatoes and cassava. Experiments with a number of forage plants are under way; also experiments in improving native stock. The station has also begun cooperating with farmers in growing alfalfa and in controlling potato diseases and insects injurious to oranges and pecans. Farmers' institutes were held in a number of places under the direction of the agriculturist, but have been temporarily suspended for lack of funds. The greenhouses have been rebuilt during the year, and improvements in botanical, entomological, and veterinary laboratories have been made. The horticulturist resigned to accept a similar position under the North Carolina board of agriculture, and has been succeeded by F. M. Rolfs, formerly of the Colorado Station.

Owing to numerous changes in the staff the affairs of the station are now in process of reorganization. At a meeting of the board of trustees late in June the resignation of the president of the university and director of the station, the entomologist, and the chemist were called for and accepted. The vacancies thus occasioned have since been filled, and arrangements have been made for the completion of investigations under way and the preparation of bulletins on the results. For the present the station is giving attention to those things of immediate importance to Florida farmers. Truck crops, fruit growing, and plant breeding will be given special attention. Experiments on feeding cotton-seed meal will be taken up and an attempt made to determine the possible effect of prolonged exposure to air as a cause of deterioration, and possibly as a contributing cause of the alleged poisonous action of cotton-seed meal when fed to hogs. The horticulturist and botanist will give special attention for a time to the diseases of potatoes, tomatoes, citrus fruits, and other Florida crops, and will attempt to develop peach growing in the northwestern part of the State. The chemist will take up a study of fertilizers for oranges, and the entomologist will give attention to the insects of citrus fruits.

### LINES OF WORK.

The principal lines of work conducted at the Florida Station during the past year were as follows: Chemistry—study of pineapple soils and of the food and fertilizer ingredients of pineapples; field experiments—cassava, corn, and other farm crops; horticulture—asparagus culture, blight of tomatoes, celery, and cantaloupes, varieties of strawberries and dewberries, studies of citrus fruits, experiments with lettuce and pineapples under cover; feeding experiments with hogs, steers, horses, and mules; veterinary science—Texas fever and nature and causes of salt sickness; entomology—white fly, San José scale, pineapple insects, and pecan bud worm.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 1,722.21 |
| Total | 16,722.21 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 67–69, and the Annual Report for 1902. The subjects of the bulletins are the white fly, pineapple culture, and cultivation of citrus groves. The Annual Report contains a financial statement and brief summaries of the work of the year in the different departments of the station.

## GEORGIA.

### **Georgia Experiment Station,** *Experiment.*[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

### GOVERNING BOARD.

Board of Directors: O. B. Stevens (*President*), *Atlanta;* J. B. Park, (*Secretary and Treasurer*), *Greensboro;* Walter B. Hill, *Athens;* H. C. White, *Athens;* R. C. Neely, *Waynesboro;* P. E. Boyd, *Leary;* J. T. Ferguson, *De Soto;* J. H. Mobley, *Hamilton;* A. J. Smith, *Conyers;* N. B. Drewry, *Griffin;* Felix Corput, *Cavespring;* John Deadwyler, *Maysville;* George Gilmore, *Warthen;* William Henderson, *Ocilla.*

### STATION STAFF.

R. J. Redding, *Director.*
H. C. White, C. E., Ph. D., *Vice-Director; Chemist.*
H. N. Starnes, B. A., *Biologist; Horticulturist.*
J. M. Kimbrough, *Agriculturist.*
Claude L. Willoughby, B. Agr., *Dairyman.*
Josephine M. Heyfron, *Stenographer; Accountant.*
D. A. Duffee, *Horticultural Foreman.*

### GENERAL OUTLOOK.

The Georgia Station has made some progress during the past year in the development of work in animal husbandry, mainly along the line of feeding dairy cattle. An experiment in inoculating cattle for Texas fever has been completed and the results prepared for publication. In order to encourage the improvement of live stock in the State several herds of cattle have been inoculated for farmers in different parts of the State, and in every case the work has been successful. Studies are being made on the life history of the peach-tree borer to discover means of combating it, and the results so far obtained seem to suggest practical methods for its control. The effect of carbon bisulphid on the viability of corn and cowpeas is being studied in view of the extensive use of this insecticide for the destruction of the weevil in the seed of these crops. Methods of preserving sweet potatoes that are adapted to household use are being studied. The station has continued to cooperate with the Bureau of Plant Industry of this Department in the endeavor to develop a hardy orange. Farmers' institutes under the auspices of the State University have been held with considerable success. About 25 farmers' institutes and the annual meetings of agricultural, horticultural, dairy, and live-stock associations of the State were attended by officers of the station staff. The dairy department of the station operated a model dairy for ten days at the State fair in Macon.

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[a] Telegraph, freight, and express address, *Griffin.*

Up to the present time the Georgia Station has confined its efforts mainly to fertilizer, variety, and cultural experiments to demonstrate the efficiency of up-to-date methods in agriculture. Such work in the future will probably be necessary to a limited extent, but should be superseded as soon as possible by demonstration work in different parts of the State arranged on a cooperative basis with the leading farmers. This will enable the station staff to devote its energies more fully to the investigation of fundamental problems concerning the agricultural interests of the State. These interests are now large and are rapidly growing. They should bend their efforts toward securing for the station such financial aid from the State as will enable it to increase its staff and broaden its investigations.

### LINES OF WORK.

The principal lines of work conducted at the Georgia Station during the past year were as follows: Field experiments—cultural and fertilizer tests; horticulture—orchard and small fruits, celery, cantaloupes, forcing vegetables; entomology; feeding experiments—soiling crops, concentrates and various other feeds for dairy cattle and pigs; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 757.96 |
| Farm products | 2,496.54 |
| Miscellaneous, including balance from previous year | 4,494.76 |
| Total | 22,749.26 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 60–63 on common ailments of breeding cattle, the fig in Georgia, corn culture, and cotton culture; and the Annual Report for 1903, which contains a brief account of the operations of the station during the year.

## HAWAII.

### **Hawaii Agricultural Experiment Station,** *Honolulu.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

#### STATION STAFF.

Jared G. Smith, B. S., M. A., *Special Agent in Charge; in charge of Farmers' Institutes.*
D. L. Van Dine, B. S. A., *Entomologist.*
Edmund C. Shorey, D. Sc., *Chemist.*
J. E. Higgins, B. S. Agr., *Expert in Horticulture.*
C. R. Blacow, *in charge of Tobacco Experiments at Pohakea (Post-Office, Paauilo).*
Q. Q. Bradford, *Farm Foreman.*

#### GENERAL OUTLOOK.

The main lines of inquiry at the Hawaii Station have been continued as heretofore and considerable progress has been made in developing new work and in improving the station facilities for investigation. In cooperation with the insular board of agriculture and the Hilo Boarding School experiments in the cultivation of cacao and bananas have been started. Several hundred banana plants have been obtained from Costa Rica for the purpose of conducting selection experiments to secure a type of banana with better shipping qualities than those now produced in Hawaii. These plants were secured from the United Fruit Company through the cooperation of the Bureau of Plant Industry of this Department. The horticulturist has prepared a bulletin on bananas which not only treats of the cultivation and marketing of this fruit, but also brings together descriptions of a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are also being continued on the cultivation and fertilization of the banana, and experiments in propagating mangoes and alligator pears have been started. Experiments for the purpose of securing a type of tobacco especially adapted to Hawaiian conditions have been conducted in cooperation with tobacco growers. Under the immediate direction of the special agent in charge investigations have been made with some of the fungus diseases of coffee, sugar cane, and other economic plants, and a comparative test of grasses and forage plants has been undertaken in cooperation with the Hawaii Live Stock Breeders' Association. The chemist has undertaken soil investigations, and the entomologist has completed and published results on an investigation of the leaf hopper of sugar cane. This insect made its appearance quite recently and has proved to be a very serious pest in some districts.

The staff of the station has been strengthened by the appointment of a horticulturist and the equipment improved by the erection of a new insectary adjacent to the entomological laboratory, two small cottages for laborers, an addition to one of the stables, the establishing of telephone connection between the main buildings and the city, the laying out of permanent plats for experiments, and the clearing of some 15 acres of additional land. A considerable number of books and periodicals have been added to the library. Owing to a marked decrease in the revenues of the island the appropriations made to the station by the insular legislature were greatly reduced at a special session of the legislature. The $5,000 annual maintenance fund was cut to $2,730, the $2,000 for salary of the chemist was withdrawn, and the $600 for stenographic assistance was cut out. Notwithstanding this reduction in local funds the station enjoys the confidence of the people, who are making frequent demands upon it for aid, and through their various organizations are cooperating with it.

### LINES OF WORK.

The principal lines of work conducted at the Hawaii Station during the past year were as follows: Field experiments—varieties of cotton, tobacco, hemp, sorghum, potatoes, taro, cultural experiments; horticulture—experiments with strawberries, bananas, and cacao, growing of grape cuttings; diseases of plants and animals—fusarium diseases of potatoes, taro rot, diseases of poultry; entomology—study of injurious insects and means for their repression.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 289.50 |
| Total | 15,289.50 |

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 4, on the cultivation of sisal in Hawaii; Bulletin 5, on a sugar-cane-leaf hopper in Hawaii, and Bulletin 6, on mosquitoes in Hawaii. The fourth report on the investigations in Hawaii, giving a detailed account of the operations during the year 1904, has been prepared by the special agent in charge of the Hawaii Station and is given on page 361.

## **Hawaiian Sugar Planters' Experiment Station**, *Honolulu*.

### GOVERNING BOARD.

Trustees of Hawaiian Sugar Planters' Association: E. D. Tenney (*President*), W. G. Irwin, H. A. Isenberg, W. O. Smith, G. H. Robertson, F. A. Schaefer, H. P. Baldwin, F. M. Swanzy, B. F. Dillingham. Station Committee: W. M. Giffard, G. H. Robertson, H. A. Isenberg, G. M. Rolph, Andrew Adams, E. E. Paxton, J. M. Dowsett.

### STATION STAFF.

C. F. Eckhart, *Director of Agricultural Division*; *Chief Chemist*.
S. S. Peck, B. S., PH. G., *First Assistant Chemist*.
F. R. Werthmueller, B. S., *Assistant Chemist*.
Firman Thompson, B. S., *Assistant Chemist*.
A. E. Jordan, *Assistant Chemist*.
E. G. Clarke, *Agriculturist*.
T. Lougher, *Field Foreman*.
A. Koebele, *Consulting Entomologist*.
R. C. L. Perkins, B. A., *Superintendent of Division of Entomology*.
Alexander Craw, *Consulting Entomologist*.
G. W. Kirkaldy, *Assistant Entomologist*.
F. W. Terry, *Assistant Entomologist*.
Otto H. Swezey, *Assistant Entomologist*.
C. H. McBride, *Clerk*.
M. E. Madeira, *Stenographer*.

### GENERAL OUTLOOK.

The work of this station during the past year has been continued along the same lines as formerly, and has included chemical investigations on the manufacture of sugar; the investigation of sugar-house products, soils, fertilizers, and irrigation waters, and field work, including irrigation of cane, variety tests of cane, fertilizer experiments, and other cultural investigations bearing on the economic limitations of intensive agriculture.

The area devoted to field experiments has recently been extended, and there is in course of erection one main building, containing offices for the director of the agricultural division and the superintendent of the division of entomology, together with commodious laboratories and working rooms for the division of entomology; two insectaries for the entomological division, and one large cane propagation house for the agricultural division.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 11, on recent experiments with saline irrigation, and the Annual Report for 1903.

## IDAHO.

### **Agricultural Experiment Station of the University of Idaho,** *Moscow.*

Department of the University of Idaho.

### GOVERNING BOARD.

Board of Regents: Chas. L. Heitman* (*President*), *Rathdrum;* Mrs. William H. Ridenbaugh* (*Vice-President*), *Boise;* Geo. C. Parkinson* (*Secretary*), *Preston;* Edward S. Sweet, *Grangeville;* J. H. McCarthy, *Wallace.*

### STATION STAFF.

H. T. French, M. S., *Director; Agriculturist.*
L. F. Henderson, Ph. B., *Botanist.*
J. M. Aldrich, M. S., *Entomologist.*
L. B. Judson, B. S., *Horticulturist.*
G. A. Crosthwait, B. S., *Agronomist.*
C. N. Little, A. M., Ph. D, *Irrigation Engineer.*
J. S. Burd, B. S., *Chemist.*
W. L. Payne, *Treasurer.*
W. G. Harrison, B. A., *Clerk.*
Prentice Moore, *Farm Foreman.*

### GENERAL OUTLOOK.

The Idaho Station has been extending its work in several directions and is pursuing a more aggressive policy toward the agriculture of different parts of the State. On the farm a herd of pure-bred Shorthorns has been developed from a nucleus purchased with a special State appropriation. Experiments are being made in fattening calves with skim milk and whole oats, the latter being fed when the calves are only three or four days old. The experiment thus far has been an entire success. Breeding and improvement of plants is a prominent feature of the farm work. An attempt is being made to improve wheats adapted to that region and to secure a variety of corn that will mature. Among the forage crops special attention is being paid to alfalfa and clover, both of which do well, the former especially being profitable to the farmers because of the big returns which it yields. Experiments are being made in pasturing pigs on peas, at the same time feeding them grain and milk, in comparison with pigs shut up and fed grain and milk. As high as $54 an acre has been realized from peas utilized in this way. The horticulturist is testing orchard cover crops and conducting experiments in a greenhouse laboratory in seed testing, inoculation of clover, etc. The chemist is working mainly on alkali and alkali soils, on the gluten content of wheats as a basis for blending, and foods for the dairy and food commission. The reclamation of alkali lands in southern Idaho is one of the important problems upon which the investigations of the chemist have a bearing. The irrigation engineer has not as yet done any irrigation work, but has made a study of rock for road building, which is a matter of considerable importance, since macadam roads are being built to a considerable extent.

The Idaho Station is doing much outside work, including the carrying on of farmers' institutes with a State appropriation of $4,000, which has proven very popular. It has also gained warm support through its alkali work in the southern part of the State and its dairy propaganda in the north. As a result of the latter work the dairy industry is growing quite rapidly in that part of the State, and hand separators are coming rapidly into use for separating the cream. The staff has been strengthened by the appointment of an agronomist, and a chemist who devotes his entire time to the station. The land available for experimental purposes has been increased by the purchase, with State and university funds, of a 40-acre tract lying between the university and the farm. The growing popularity of the station is indicated by a large increase in the bulletin mailing list and by the apparently favorable attitude of the people toward securing an appropriation of $40,000 or $50,000 for a new agricultural building. The director has been made fully responsible for the conduct of the station and has received the cordial support of the president of the university and the governing board, and the result is a more hopeful outlook for the station than ever before.

### LINES OF WORK.

The principal lines of work conducted at the Idaho Station during the past year were as follows: Chemistry—studies of wheats, alkali and alkali soils and foods, miscellaneous analytical work; physics; botany—studies of plant diseases and their remedies, experiments with grasses and forage crops; field experiments—plant breeding, tests of various grasses and other forage crops for pasture and hay, experiments with cereals desirable for introduction, rotation experiments; horticulture—cultural and variety tests of garden crops, fruits, and forest trees, pruning experiments and inoculation experiments; entomology; feeding experiments—cattle, sheep, and swine.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 955.79 |
| Farm products | 844.15 |
| Total | 16,799.94 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 39–41, on some experiments with fungus diseases, winter spraying for the apple aphis, and grasshopper and cricket outbreaks; and the Annual Report for 1903, in which a brief summary of operations in the different departments of the station is given.

## ILLINOIS.

### Agricultural Experiment Station of the University of Illinois, *Urbana.*

Department of the University of Illinois.

#### GOVERNING BOARD.

Board of Trustees of the University: Governor Richard Yates, *Springfield;* James K. Dickirson, *Lawrenceville;* Alfred Bayliss, *Springfield;* Mrs. Alice A. Abbott, *1108 West Illinois st., Urbana;* Frederic L. Hatch (*President*), *Spring Grove;* Augustus F. Nightingale, *159 La Salle st., Chicago;* Alexander McLean, *Macomb;* Samuel A. Bullard, *Springfield;* Mrs. Carrie T. Alexander, *Belleville;* William B. McKinley, *Champaign;* L. H. Kerrick, *Bloomington;* Laura B. Evans, *Taylorville;* William L. Pillsbury (*Secretary*), *Urbana;* E. G. Keith (*Treasurer*), *Chicago.*

#### STATION STAFF.

Eugene Davenport, M. Agr., *Director.*

T. J. Burrill, Ph. D., LL. D., *Chief in Botany.*

C. G. Hopkins, Ph. D., *Chief in Agronomy and Chemistry.*

J. C. Blair, *Chief in Horticulture.*

H. W. Mumford, B. S., *Chief in Animal Husbandry.*

W. J. Fraser, M. S., *Chief in Dairy Husbandry.*

L. H. Smith,[a] M. S., *Assistant Chief in Chemistry and Plant Breeding.*

A. D. Shamel,[a] B. S., *Chief in Farm Crops.*

J. W. Lloyd, M. S. A., *Assistant Chief in Horticulture.*

A. J. Glover, B. Agr., *Superintendent of Dairy Field Work, Elgin Region.*

J. G. Mosier, B. S., *Assistant Chief in Soil Physics.*

J. W. Hart, *Assistant Chief in Dairy Manufactures.*

C. F. Hottes, Ph. D., *Assistant Chief in Vegetable Physiology.*

H. A. Hopper, B. S. A., *Assistant in Dairy Husbandry.*

C. C. Hayden, B. S. A., *Assistant in Dairy Husbandry.*

A. N. Hume, M. S., *First Assistant in Crop Production.*

E. S. Good, B. S., *Assistant in Animal Husbandry.*

C. S. Crandall, M. S., *Assistant Chief in Pomology.*

Carl E. Lee, B. S., *Assistant in Dairy Husbandry.*

Jas. T. Barrett, A. B., *Assistant Botanist.*

J. H. Pettit, Ph. B., *First Assistant in Soil Analyses.*

E. M. East, B. S., *First Assistant in Plant Breeding.*

W. F. Pate, M. S., *Assistant in Chemistry.*

R. C. Obrecht, B. S. A., *First Assistant in Horses.*

Clifford Willis, B. S., *Assistant in Soil Physics.*

Ira O. Schaub, B. S., *Assistant in Chemistry.*

William Dietrich, B. S. A., *First Assistant in Swine Husbandry.*

Louis D. Hall, B. S. Agr., *First Assistant in Animal Husbandry.*

Harry H. Love, B. S., *Assistant in Chemistry.*

Andrew Ystgard, B. Agr., B. S., *Assistant in Chemistry.*

Jerome E. Readhimer, B. S., *Superintendent of Soil Experiment Fields.*

Kate McIntyre, *Secretary.*

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[a] On leave.

### GENERAL OUTLOOK.

Increased appropriations from the State have enabled the Illinois Station to specialize and strengthen its staff and extend greatly its investigations along lines previously planned. Thus, two men now give their entire time to beef cattle, one to horses, and one to swine, dividing their services between investigations and teaching. Six men are engaged in dairy work, one giving his time wholly to manufactured products, one to creamery work, and three to fieldwork. These field dairymen are engaged largely in districts adjacent to Chicago and St. Louis, and are studying methods and conditions and conducting a vigorous crusade for more hygienic methods in producing and handling milk and dairy products.

There has also been a marked development in the fieldwork in agronomy and horticulture. The soil survey, in cooperation with the Bureau of Soils of this Department, now covers 19 counties, and the field experiments with fertilizers and renovating crops have been extended to many new localities. The horticultural work follows practically the same lines as formerly, but is being extended to new localities. The station is cooperating with this Office in studying losses brought about by different methods of cooking meat, and the influence of time, temperature, breed, age of marketing, method of slaughtering, and other related conditions upon the flavor and quality of cooked meat.

The college of agriculture is devoting considerable sums of money to the construction of bulidings which will improve the facilities for experimental work. It has an annual appropriation of $50,000, half of which is available for building purposes. With these funds it is planned to construct a series of farm laboratories, one for each kind of farm animal (beef cattle, dairy cows, horses, sheep, and swine), one for agronomy, and one for horticulture. A $25,000 brick building for beef cattle and a $12,500 agronomy building are now being erected.

The extension work of the college and station has been continued as mentioned above in connection with the work in horticulture and dairying, also in farmers' institutes, and in arousing interest in better agriculture among rural school children. In all this work the institution has the active support and cooperation of the educational and agricultural officers and associations of the State. The station is solving successfully the problem of using efficiently the large funds at its disposal, and is doing much to advance the farming interests of the State.

### LINES OF WORK.

The principal lines of work conducted at the Illinois Station during the past year were as follows: Chemistry—studies of the chemical composition of corn; bacteriology; pot and field experiments—pot experiments with type soils from different parts of the State, studies on management of soils conducted on type soils in fifteen or sixteen different regions, inoculation experiments with alfalfa, experiments with sugar beets; horticulture—experiments in orchard management, renovation of orchards, cold storage investigations, experiments with garden vegetables and flowers; forestry; plant breeding—experiments in breeding and selecting corn to change the protein, oil, and starch contents; animal husbandry—study of dairy conditions in different parts of the State, study of market grades of beef cattle, experiments on cost of beef production and on methods of housing cattle, feeding experiments with pigs; diseases of plants—study of bitter rot and other rots of apples, apple scabs, and cankers; diseases of animals; entomology, and extension work in orchard management.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15, 000. 00 |
| State appropriation | 85, 000. 00 |
| Fees | 870. 00 |
| Farm products | 585. 73 |
| Balance from prevous year | 1, 637. 54 |
| Total | 103, 093. 27 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 85–94 and the Annual Report for 1903. The subjects of the bulletins are as follows: Records of individual cows on dairy farms; climate of Illinois; the structure of the corn kernel and the composition of its different parts; soil treatment for wheat in rotations, with special reference to southern Illinois soils; notes on the insecticide use of the gasoline blast lamp; fattening steers of the various market grades; preventing contamination of milk; city milk supply; soil treatment for peaty swamp lands, including reference to sand and alkali soils; nitrogen bacteria and legumes. The station also issued a large number of circulars on investigations and on topics of current interest to the people of the State.

# INDIANA.

## **Agricultural Experiment Station of Indiana,** *Lafayette.*

Department of Purdue University.

### GOVERNING BOARD.

Board of Trustees: William V. Stuart (*President*), *Lafayette;* E. A. Ellsworth (*Secretary*), *Lafayette;* J. M. Fowler (*Treasurer*), *Lafayette;* William A. Banks, *Laporte;* James M. Barrett, *Fort Wayne;* David E. Beem (*Vice-President*), *Spencer;* Charles Downing, *Greenfield;* Sylvester Johnson, *Irvington;* Charles Major, *Shelbyville;* C. B. Stemen, *Fort Wayne;* J. H. Van Natta, *Lafayette.*

### STATION STAFF.

Arthur Goss, M. S., A. C., *Director; Chemist.*
W. C. Latta, M. S., *Agriculturist.*
James Troop, M. S., *Horticulturist.*
J. C. Arthur, D. Sc., *Botanist.*
A. W. Bitting, D. V. M., *Veterinarian.*
M. L. Fisher, B. S., *Assistant Agriculturist.*
J. H. Skinner, B. S., *Animal Husbandman.*
A. T. Wiancko, B. S. A., *in Charge of Field Experiments.*
W. J. Jones, jr., M. S., A. C., *Assistant Chemist.*
H. E. Van Norman, B. S., *Dairying.*

### GENERAL OUTLOOK.

The work of the Indiana Station has been continued with no very material change except in the development of additional investigations in agronomy and in breeding and crossing bacon hogs. The experimental work in agronomy has been developed along the lines of breeding wheat and oats, testing soiling crops, and cooperative experiments, largely with former students in different parts of the State, on a number of different crops, such as winter wheat, alfalfa, soy beans, and corn. The station is also cooperating with the Bureau of Plant Industry of this Department in experiments with grasses and other economic plants and studies of the rusts of grain, and with the Bureau of Chemistry in studying the effect of environment on the chemical composition of sugar beets. The veterinarian has been giving special attention to diseases of swine, a subject of great importance in the State, and has prepared a monograph summarizing the results of his own observations, as well as those of other investigators, on these diseases.

An event of great importance to the station was the action of the board of control last June in turning over the management and maintenance of the farm to the university and the inspection work of the State chemist to the station. This relief from the expense of maintaining the farm, together with the receipts from the fertilizer inspection, will benefit the station financially to the extent of about

$3,000 a year. At the same time provision has been made for the station to use, free of rent, such buildings and portions of the farm as it needs for experimental purposes and to have the proceeds from the portions of the farm used. The university is erecting a $10,000 cattle barn, which will be utilized to some extent for experimental work. Notwithstanding these improved conditions the station is greatly in need of more funds to procure special equipment for the work in agronomy, animal husbandry, and plant diseases, and to further develop the work in agronomy and animal husbandry. Considering the great agricultural interests of Indiana, this station has a relatively meager income and must necessarily conduct its work on a comparatively limited scale.

### LINES OF WORK.

The principal lines of work conducted at the Indiana Station during the past year were as follows: Chemistry—studies of sugar beets, the nitrogen-free extract of feeding stuffs, the improvement of muck soils of the State, fertilizer experiments with tomatoes, study of chemical composition of corn at different stages of growth, corn breeding; pot and field experiments—breeding, cultural and fertilizer experiments with cereals and forage crops, rotations; pot experiments with legumes and cereals to test the efficiency of soil inoculation; horticulture—cross fertilization of apples, variety tests of fruits and vegetables, surface and subirrigation for vegetables in hothouses; feeding experiments—comparison of tankage and other feeds for swine, feeding dairy cows; diseases of plants and animals—studies of diseases of cattle, sheep, and pigs, treatment of oats and wheat for smut, study of edible fungi, and rusts of sedges; breeding bacon hogs, and entomology.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 2,416.72 |
| Total | 17,416.72 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 95–99 and the Annual Report for 1903. The subjects treated in the bulletins included unproductive black soils, the care of milk and the making of butter on the farm, the value of distillery-dried grains as a food for work horses, three edible toadstools, and tests of small fruits.

## IOWA.

### Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

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STATION STAFF.

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H. E. Summers, B. S., *Entomologist.*
W. J. Kennedy,[a] B. S. A., *Vice-Director; Animal Husbandman.*
G. L. McKay, *Dairying.*
P. G. Holden, M. S. B. PD., *Agronomist.*
W. H. Stevensen, A. B., *Soils.*
F. W. Bouska, M. S. A., *Dairy Bacteriologist.*
C. J. Zintheo, B. S., *Farm Mechanics.*
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E. E. Little, M. S. A., *Assistant Horticulturist.*
W. W. Smith, B. S. A., *Assistant Animal Husbandman.*
C. E. Ellis, *Assistant Agricultural Chemist.*
C. Larsen, M. S. A., *Assistant in Dairying.*
L. S. Klinck, B. S. A., *Assistant in Farm Crops.*
T. S. Hunt, *Assistant Agronomist.*
G. I. Christie, B. S. A., *Assistant in Soils.*
O. W. Willcox, PH. D, *Assistant in Soils.*
Wayne Dinsmore, B. S. A., *Assistant Animal Husbandman.*
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J. E. Guthrie, M. S., *Assistant Entomologist.*
C. W. Gay, D. V. M., *Assistant in Animal Husbandry.*
J. W. Jones, *Assistant Agronomist.*
Miss C. M. King, *Artist.*
Julius Erdman, B. S. A., *Gardener.*
E. S. Gardner, *Photographer.*
E. C. Gasser, *Assistant in Farm Mechanics.*
H. M. Bainer, M. S. A., *Assistant in Farm Mechanics.*
H. P. Baker, B. S., M. F., *Assistant Horticulturist.*
M. L. Merritt, *Assistant Horticulturist.*
L. G. Michael, *Agricultural Chemist.*
Harriette Kellogg, A. M., *Assistant Botanist.*
W. H. Ogilvie, *Bulletin Editor.*
H. O. Sampson, *Bulletin Clerk.*

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[a] On leave.

### GENERAL OUTLOOK.

The Iowa Station has made good progress during the past year. Its work has been a continuation and a development of investigations mentioned in the last report of this Office. The feeding experiments at the Brookmont Farm to compare the feeding qualities of northern and southern range-bred cattle resulted in an unexpectedly favorable showing for the southern cattle. Careful investigations of the soil conditions of the State have been continued partly in cooperation with farmers, who are also aiding the station in testing the durability of different kinds of wood for fence posts and the effectiveness of preservatives in increasing the durability of wood. The experiments for the improvement of corn and other cereal crops in cooperation with the Bureau of Plant Industry of this Department are now supplemented by cooperative work on county poor farms in ten or a dozen counties throughout the State. There is some thought of making these farms permanent features of the experimental work in the State. The station is also cooperating with the Bureau of Plant Industry in fiber investigations and experiments on truck crops, with the Bureau of Animal Industry in breeding range sheep, and with this Office in tests of windmills as a motive power for irrigation and other farm work.

Appropriations were made during the past year for the erection of a new dairy building to cost about $60,000. This structure is now partially constructed. There was also an appropriation of $5,000 for a horticultural barn and nursery, $27,000 for the purchase and equipment of a dairy farm, and $15,000 additional for the experiment station. This makes the regular State appropriation for the experiment station $25,000, which, with the Hatch fund and some funds from private sources and from cooperative work, brings up the total resources for experimental work to about $45,000. Excellent laboratories have been fitted up for work in soils and farm crops, and additional instructors appointed for this work. There have also been appointed a forester, who will give half of his time to the college and station and half to investigations for the Bureau of Forestry of this Department, and a bulletin editor, who will have charge of a course in agricultural journalism to be established in the college.

Both the station and the college with which it is connected are rapidly extending their influence and usefulness among the farmers of Iowa. The attendance of about 700 farmers at the short courses in stock and grain judging last winter is an indication of the high regard in which the institution is held by the people of the State. This is further evidenced by the very liberal appropriations made for the college and station in recent years by the State legislature. The station is doing a very large amount of valuable work, and at the same time is paying much attention to strengthening its force, improving its equipment, and developing better agricultural conditions throughout the State.

### LINES OF WORK.

The principal lines of work conducted at the Iowa Station during the past year were as follows: Chemistry; botany; field experiments—cultural and breeding experiments with corn, wheat, and other cereals, flax, legumes, sorghum, teosinte, millet, Kafir corn, sugar beets, carrots, and potatoes; horticulture—crossing of fruits, tests of cover crops, cross pollination of apples in different parts of the State, cultural and variety tests of celery, tests of ornamentals, top-working of apples on crab stock; diseases of plants; animal husbandry—feeding experiments with cattle and sheep in carload lots, and with horses and swine, breeding range sheep and horses; entomology; dairying; forestry; rural engineering, and good roads investigations.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 10,000.00 |
| Individuals | 400.00 |
| Fees | 41.43 |
| Farm products | 4,420.48 |
| Miscellaneous | 185.95 |
| Total | 30,047.86 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 69–78. The subjects of these bulletins were the chicken mite, some weeds of Iowa, the keeping quality of butter, cold storage of apples, cherries and cherry growing in Iowa, breakfast foods, the feeding value of soft corn for beef production, the moisture content of butter and methods of controlling it, selecting and preparing seed corn, and drainage conditions in Iowa.

## KANSAS.

### Kansas Agricultural Experiment Station, *Manhattan.*

Department of Kansas State Agricultural College.

#### GOVERNING BOARD.

Board of Regents: J. S. McDowell * (*President*), *Smith Center;* C. E. Friend * (*Vice-President*), *Soldier;* E. T. Fairchild[a] (*Loan Commissioner*), *Ellsworth;* G. S. Murphey, *Manhattan;* J. W. Berry,* *Jewell;* E. R. Nichols (*Secretary ex officio*), *Manhattan;* J. O. Tulloss, *Sedan.*

#### STATION STAFF.

J. T. Willard, M. S., *Director; Chemist.*
E. A. Popenoe, A. M., *Entomologist.*
H. F. Roberts, M. S., *Botanist.*
Albert Dickens, M. S., *Horticulturist.*
A. M. Ten Eyck, B. Agr., M. S., *Agriculturist.*
Oscar Erf, B. S. Agr., *Dairyman, Animal Husbandman.*
Lorena E. Clemons, B. S., *Secretary.*
V. M. Shoesmith, B. S., *Assistant in Feeding and Field Work.*
George A. Dean, B. S., *Assistant Entomologist.*
C. L. Barnes, D. V. M., *Assistant in Veterinary Science.*
Roscoe H. Shaw, B. S., *Assistant Chemist.*
Robt. E. Eastman, M. S. A., *Assistant Horticulturist.*
R. J. Kinzer, B. S. Agr., *Assistant Animal Husbandman.*
G. C. Wheeler, B. S., *Assistant in Feeding Experiments.*
Geo. F. Freeman, B. S., *Assistant Botanist.*
Alice M. Melton, B. S., *Clerk to Director.*
J. G. Haney, B. S., *Superintendent of Fort Hays Branch Experiment Station, Hays.*
O. H. Elling, *Foreman of Fort Hays Branch Experiment Station, Hays.*

#### GENERAL OUTLOOK.

The work of the Kansas Station has been continued as heretofore, with the exception of a few noteworthy additions. Investigations with flax have been taken up for the first time, and work with vegetables suitable for use in canning factories has been started. The veterinary department has made an extensive study of cattle dips, some of the experiments being to determine how long these can be used after mixing. Considerable attention has been given to the study of root systems of farm crops, and in connection with the extensive cereal-breeding experiments a number of hybrids between wheat and other grains have been produced. The work with cereals is being done in cooperation with the Bureau of Plant Industry of this Department, with which the station is also cooperating in fiber investigations. A soil survey in cooperation with the Bureau of Soils and irrigation investigations in cooperation with this Office are other features of the station work. Much of the work with cereals and grasses is being done at the Fort Hays Substation, which is supported by the State. During the past year a $40,000 auditorium for the use of the college and a $15,000 dairy building for the college and station were completed. A new silo has been constructed and a water system installed, which renders the station independent of the city water supply. The land that was leased for the use of the station has been purchased by the college and will be devoted to the same use as formerly.

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[a] In special charge of the business of the Fort Hays Branch Station.

The Kansas Station has in hand a large amount of useful work, but the unsatisfactory conditions arising from the lack of time for investigation on the part of station officers still exist. With the growth of the college the demands on the time of its faculty for class-room work have necessarily increased, and in some cases have interfered with the energetic pursuit of the investigations of the station. Funds should be provided by the State to meet the enlarged needs of the college in its departments of instruction, and the assignments of station officers for teaching should be modified so as to enable them to do more effective work for the station. Assurance has been given that the college authorities will undertake a readjustment of work in this direction. Considering the large agricultural interests of Kansas, the funds at the disposal of the station at Manhattan are relatively meager.

### LINES OF WORK.

The principal lines of work conducted at the Kansas Station during the past year were as follows: Soils—moisture determinations, bacteriological investigations; horticulture—interpollinating apples, selecting and improving native fruits; plant breeding—with wheat, corn, cowpeas, and other crops; field experiments—growing drought-resistant crops, cultural and variety tests of grasses and numerous other crops; feeding and digestion experiments—maintenance ration, experiments with wheat and wheat straw, feeding calves; diseases of animals—infectious sore mouth of cattle, cattle distemper, blackleg, poisoning from weeds; entomology; dairying, and extermination of prairie dogs and gophers.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | [a] 17,900.00 |
| Farm products | 4,184.55 |
| Balance from previous year | 1,164.84 |
| Total | 38,249.39 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

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[a] For Fort Hays Substation.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 117–124 and the Annual Report for 1903. The bulletins are on the following subjects: Bacteria of the soil, flesh and fat in beef, tests of forest trees, treatment and utilization of flood-damaged lands, blackleg and vaccination, crop experiments in 1903, and experiments in feeding steers and in breeding and feeding pigs. The Annual Report includes the usual administrative reports, and in addition an outline of the work at Fort Hays in cooperation with this Department and of the attempted destruction of gophers and prairie dogs.

## KENTUCKY.

### **Kentucky Agricultural Experiment Station,** *Lexington.*

Department of the Agricultural and Mechanical College of Kentucky.

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Board of Trustees: Governor J. C. W. Beckham (*ex officio*), *Frankfort;* G. B. Kinkead,* *Lexington;* John McChord, *Lebanon;* Cassius M. Clay, *Paris;* W. R. Ramsey, *London;* William C. Bell, *Harrodsburg;* D. F. Frazee* (*Secretary*), *Lexington;* Robert L. Stout, *Versailles;* B. M. Brooks, *Slaughterville;* F. A. Hopkins, *Prestonburg;* Charles B. Nichols,* *Lexington;* J. K. Patterson,* (*ex officio*), *Lexington;* T. Carpenter, *Scottsville;* H. S. Barker, *Louisville;* McDougal Ferguson, *Paducah;* J. F. Hager, *Ashland;* R. W. Nelson, *Newport.*

### STATION STAFF.

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A. M. Peter, M. S., *Chemist.*
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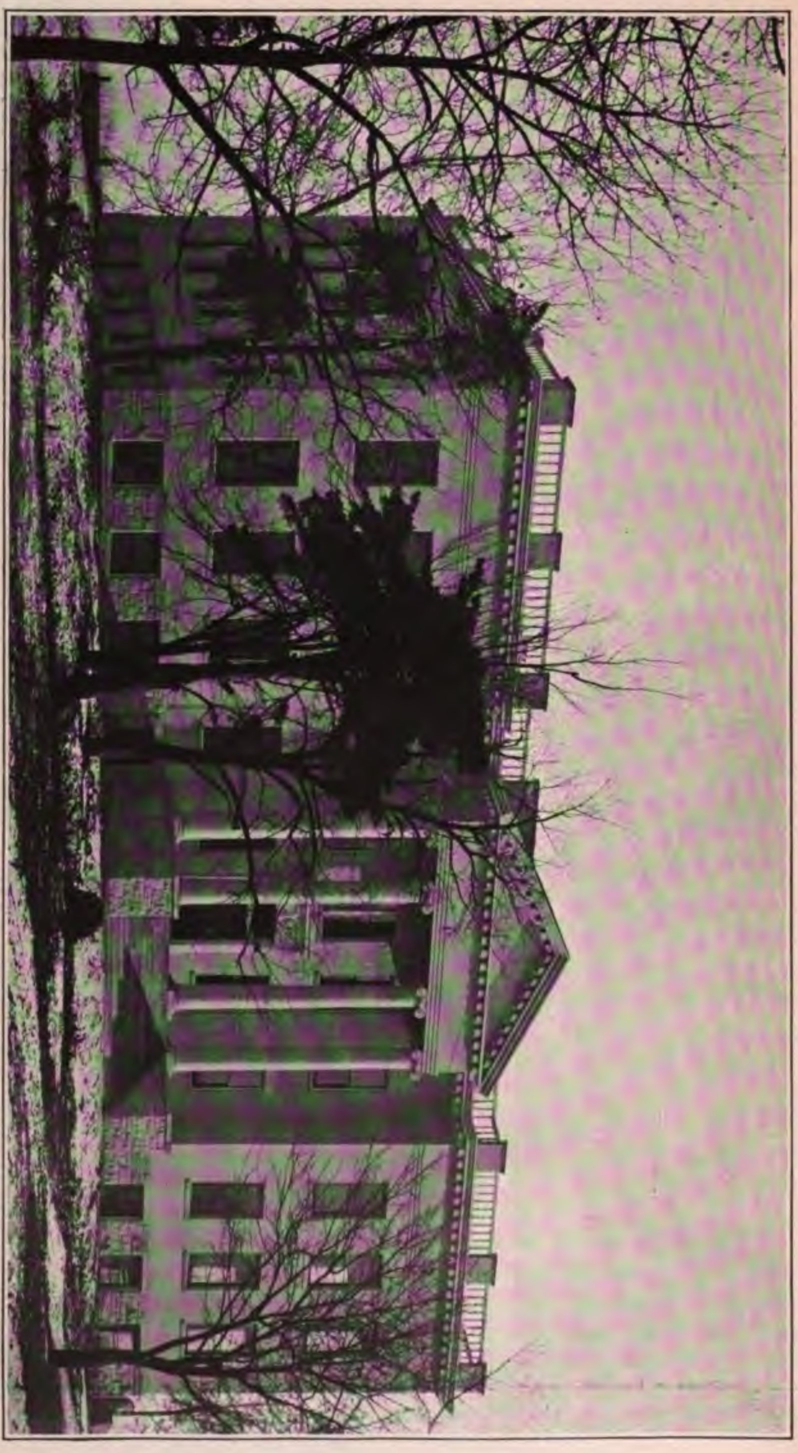
H. Garman, *Entomologist, Botanist.*
J. N. Harper, B. S., *Agriculturist.*
J. O. La Bach, M. S., *Chemist of Food Division.*
W. H. Scherffius, B. S., *Chemist.*
J. W. Nutter, *Assistant Dairyman.*
O. M. Shedd, M. S., *Assistant Chemist.*
S. D. Averitt, M. S., *Assistant Chemist.*
J. D. Turner, B. Ped., *Secretary to Director.*
R. M. Allen, B. A., *Secretary of Food Division.*
Mary L. Didlake, M. S., *Assistant Entomologist and Botanist.*
G. N. Keller, *Assistant Entomologist and Botanist.*

### GENERAL OUTLOOK.

The Kentucky Station has continued its work as heretofore, with the exception of the experiments in animal breeding, which have been interrupted by the resignation of the animal husbandman to accept a position as special agent in charge of the Porto Rico Station. The feeding experiments and those in dairying will be continued. Extensive studies are being carried on with wheat, with reference to

PLATE I.



NEW MAIN BUILDING AT KENTUCKY STATION.

the influence of time of ripening on the gluten content and the influence of climate on hard and soft varieties. There are also breeding experiments with wheat, all available types being crossed with Oakley, a promising variety in the State. Corn breeding and a study of various types of White Burley tobacco are other features of the work in agronomy. A large amount of this work, including rotation experiments, the studies of meadows, pastures, annual forage crops, and new grasses and forage plants, is being conducted in cooperation with the Bureau of Plant Industry of this Department. Cooperation with the Bureau of Chemistry on sugar-beet investigations has been continued. Particular attention is also being given to the relative value of clover seed from different regions, and the results thus far are favorable to the use of locally grown seed.

The chemist is investigating the poisoning of cattle, studying soils and methods of determining potash and nitrogen, and making a large number of analyses in connection with the studies of sugar beets, cereals, feeding stuffs, forage plants, etc. He has been studying the relation between the physical appearance of selected wheat and its gluten content, and in this work has devised methods for analyzing the very small samples secured. The studies thus far with sorghum and sugar beets indicate that these crops are not well adapted to the State. The entomologist and botanist has been studying the eradication of broom rape, and finds that common salt and muriate of potash are both very promising when applied to the soil. He is studying the influence of this parasite on the character of the hemp fiber, which seems to be greatly weakened in the plants affected by the broom rape. He is also making studies of nitrogen-assimilating organisms and preparing cultures for distribution. Among the insects and plant diseases to which attention is given are the cabbage worm and the corn worm, the latter a serious pest to tobacco; cabbage wilt; celery blight, and tomato rot. The last legislature of the State passed a law providing for seed inspection for purity, and increased the appropriation for the enforcement of the pure-food law from $7,500 to $10,500 a year. Soil investigations are being carried on in connection with the State geological survey, which was reestablished by the last legislature. A new station building of buff pressed brick has been erected at a cost of about $20,000. (Pl. I.) The building is well constructed and admirably adapted to the needs of the station. The quarters heretofore occupied by the station will be turned over to the college for a chemical laboratory. In general, the station has had a very prosperous year and is in a good position to render efficient aid to the agriculture of the State.

### LINES OF WORK.

The principal lines of work conducted by the Kentucky Station during the past year were as follows: Chemistry; soils; analyses of fertilizers, foods, and feeding stuffs; inspection of orchards and nurseries; field experiments—hemp, tobacco, cereals, legumes, fertilizers; horticulture; plant breeding—wheat, corn, and sorghum; breeding of animals; pig feeding; diseases of plants—broom rape of hemp and tomato rot; entomology—the Hessian fly, apiculture; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation, including balance from previous year | 10,208.18 |
| Fees, including balance from previous year | 19,982.42 |
| Farm products, including balance from previous year | 8,277.86 |
| Miscellaneous, including balance from previous year | 323.01 |
| Total | 53,791.47 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 107–112 and the Annual Report for 1900. Two of the bulletins are on commercial fertilizers, the others on nursery inspection and the pest of seventeen-year locusts in Kentucky, some results in steer feeding, and the Hessian fly in 1902–3.

## LOUISIANA.

**No. 1. Sugar Experiment Station,** *Audubon Park, New Orleans.*
**No. 2. State Experiment Station,** *Baton Rouge.*
**No. 3. North Louisiana Experiment Station,** *Calhoun.*

Department of Louisiana State University and Agricultural and Mechanical College.

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## STATION STAFF.

### Sugar Experiment Station, *Audubon Park, New Orleans.*

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R. E. Blouin, M. S., *Assistant Director, Chemist.*
P. L. Hutchinson, B. S., *Chemist.*
E. F. Lines, *Assistant Geologist.*
Robert Glenk, PH. G., B. S., *Chemist.*
C. A. Browne, jr., PH. D., *Chemist.*
J. E. Halligan, B. S., *Assistant Chemist.*
A. F. Reinecke, *Assistant Geologist.*
G. D. Harris, M. S., M. A., *Geologist.*
G. H. Hardin, B. S., *Assistant Chemist.*
S. G. Chiquelin, *Chemist, Sugar Maker.*
D. L. Williams, *Farm Manager.*
J. K. McHugh, *Secretary, Stenographer.*

### State Experiment Station, *Baton Rouge.*

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W. H. Dalrymple, M. R. C. V. S., *Veterinarian.*
H. Skolfield, *Treasurer.*
F. H. Burnette, *Horticulturist.*
C. E. Coates, PH. D., *Chemist.*
B. H. Atkinson, *Farm Manager.*

### North Louisiana Experiment Station, *Calhoun.*

W. R. Dodson, B. A., B. S., *Director.*
D. N. Barrow, B. S., *Assistant Director.*
Simon Baum, B. S., *Chemist.*
Eugene J. Watson, *Horticulturist.*
G. H. Malone, *Dairyman, Poultryman.*
Ivy Watson, *Farm Manager.*

## GENERAL OUTLOOK.

The work of the Louisiana stations during the past year has followed very closely the lines heretofore pursued. It covers a wide range and includes especially improvement of varieties and methods of culture of sugar cane, cotton, corn, and potatoes; tests of native and introduced varieties of forage plants, tobacco, fiber plants, and other field crops, fruits, and vegetables; rotation experiments; study of the chemical composition, digestibility, and feeding value of the by-products of rice, cotton, and sugar cane; a study of the rationale of the production and changes of sugar and other carbohydrates in cane and the improvement of methods of sugar making (sugar-house work) by strict chemical control; feeding experiments with home-grown forage plants and other available Louisiana feeds; investigations relating to injurious insects (especially the cotton-boll weevil) and animal diseases; introduction of improved breeds of cattle, sheep, and hogs; a systematic study (survey) of the soils of the State; irrigation experiments; inspection of fertilizers and Paris green; farmers' institute work. The entomologist gives nearly his whole time to boll-weevil investigations under the provisions of the Louisiana State Crop Pest Commission act of 1903, carrying an appropriation of $25,000, and in cooperation with the Bureau of Entomology of this Department. The introduction of the cotton-boll weevil into the experimental plats at Audubon Park during the summer of 1903 necessitated the complete destruction of all cotton growing at that place and resulted in the loss of many valuable varieties to which years of labor had been devoted. In connection with the geological survey of the State and in cooperation with the Bureau of Soils of this Department, the soils of the State are being mapped, classified, and analyzed, and their crop adaptations recorded. The hardy orange hybrids, which are being tested at Audubon Park in cooperation with the Bureau of Plant Industry, have fruited this year for the first time. The work of the station on seedling sugar canes has resulted in the development of two especially valuable varieties—Demerara No. 74 and Demerara No. 95—the former of which especially is rapidly displacing other varieties of cane in the State. Considerable progress has been made in demonstrating the possibility of profitably utilizing cane fiber (bagasse) in paper making and in the study of mixed feeds containing molasses.

The work of the station with alfalfa has been very successful and is resulting in the extension of the culture of alfalfa in the State. The station has demonstrated the possibility of feeding steers for the Chicago market at a profit on home-grown forage plants, finishing with rations of cotton-seed meal, rice, bran, and molasses, by-products of the three staple crops of the State. The experiments on the digestibility and nutritive value of rice bran and polish, which have just been completed, show the prevalence of adulteration of rice bran with hulls, and demonstrate that the high percentage of oil in the bran and polish is objectionable because it rapidly becomes rancid. Steps have been taken, with promise of success, to secure the establishment of mills for the extraction of rice oil, which has sufficient commercial value to make its removal profitable. This would result in the production of an improved rice feed which would compete with the corn and wheat products which are now being shipped into the State from the North and West. The experiments in truck growing at the North Louisiana Station are attracting considerable attention and have resulted in the development of truck farming, especially in connection with canning establishments.

The inspection work of the station, which formerly included fertilizers and Paris green, was increased by the passage of a law last winter regulating the sale and purity of commercial feeding stuffs. The same legislature also modified the law providing for the inspection of Paris green. Station officers continue to take an active part in farmers' institutes, of which 50 or 60 were held during the past year. The institute workers are now organized in five groups with reference to special interests—sugar, rice, fruits and agriculture, boll weevil, and diversified agriculture. These groups are generally in charge of station men. The appropriation for institutes is $2,500 from the State. The director of the station resigned recently and has been succeeded by W. R. Dodson.

The Louisiana stations have in hand a large amount of work covering a wide range of problems affecting the producers of the State. Some of the results attained are of great importance. This is especially true of studies of diseases of animals and experiments in finishing cattle for the Chicago markets, the results of which demonstrate not only that animal production is possible in Louisiana, but that it may be made a profitable means of utilizing the by-products of the leading crops of the State. They are of further importance because they lead strongly toward diversified farming.

### LINES OF WORK.

The principal lines of work conducted at the Louisiana stations during the past year were as follows:

SUGAR STATION.—Chemistry; bacteriology; soils and soil physics; field experiments—tests of fodder plants and varieties of cane; horticulture—tests of home-grown *v.* northern-grown seeds; sugar making; drainage; and irrigation.

STATE STATION.—Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments—forage crops, legumes, rotations, varieties of cotton and sugar cane; horticulture; animal husbandry—breeding and feeding for beef production; diseases of animals—inoculation for Texas fever, study of the nodular diseases of the intestines of sheep, anthrax, glanders, etc., and entomology.

NORTHERN STATION.—Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; and dairying.

### INCOME.

The income of the stations during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 20,000.00 |
| Fees | 11,558.72 |
| Farm products | 2,574.93 |
| Balance from previous year | 10,097.00 |
| Total | 59,230.65 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of these stations received during the past fiscal year were Bulletins 75-79, the Annual Report for 1903, and a circular on the Mexican cotton-boll weevil. The subjects treated in the bulletins are the preservation of cane sirups, and yeasts, molds, bacteria, and enzyms; rice; analyses of commercial fertilizers and Paris green; comparative results of seedling sugar canes D. 74 and D. 95, with our home sugar canes, and results of experiments with nodular diseases of the intestines of sheep.

## MAINE.

### **Maine Agricultural Experiment Station,** ***Orono.***

Department of University of Maine.

#### GOVERNING BOARD.

Board of Trustees: Henry Lord (*President*), *Bangor;* Elliott Wood, *Winthrop;* Chas. L. Jones,* *Corinna;* J. A. Roberts,* *Norway;* Edward B. Winslow, *Portland;* V. L. Coffin, *Harrington;* A. J. Durgin,* *Orono;* E. J. Haskell, *Westbrook;* I. K. Stetson (*Treasurer*), *Bangor.*

#### STATION STAFF.

Chas. D. Woods, B. S., *Director.*
J. M. Bartlett, M. S., *Chemist.*
L. H. Merrill, B. S., *Chemist.*
F. L. Russell, B. S., V. S., *Veterinarian.*
W. M. Munson, Ph. D., *Horticulturist.*
G. M. Gowell, M. S., *Stock Breeding, Poultryman.*
Edith M. Patch, B. S., *Entomologist.*
Gilman A. Drew, Ph. D., *Zoologist.*
H. H. Hanson, B. S., *Assistant Chemist.*
S. C. Dinsmore, B. S., *Assistant Chemist.*
Marshall B. Cummings, M. S., *Assistant Horticulturist.*
Annie M. Snow, *Stenographer.*

#### GENERAL OUTLOOK.

During the past fiscal year the Maine Station continued to direct its efforts principally to investigations on the nutrition of man and animals, poultry husbandry, and horticulture. The nutrition work, as formerly, was in cooperation with this Office, and was concerned mainly with cereal foods, wheats, and flours. Results of the studies on the food value of whole-wheat flour have been published.

In horticulture the results of studies on weeds, ginseng, cankerworm, and reciprocal crosses have been published. There was considerable orchard work, mainly with apples, Japanese plums, and dwarf pears. Attention has also been given to the pollination of apples to determine the relative potency of the pollen for different varieties, and to the top grafting of the Ben Davis and Russian varieties of apples. The work with blueberries is being continued.

The poultry work of the station is assuming considerable prominence and importance. The breeding experiments to increase egg

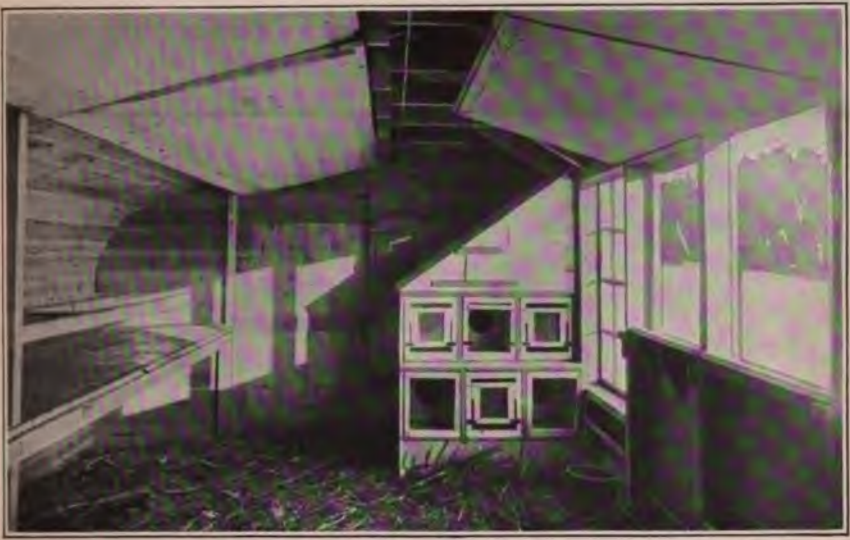

FIG. 1.—MAINE STATION—CURTAIN-FRONT POULTRY HOUSE, WITH TRAP NESTS.

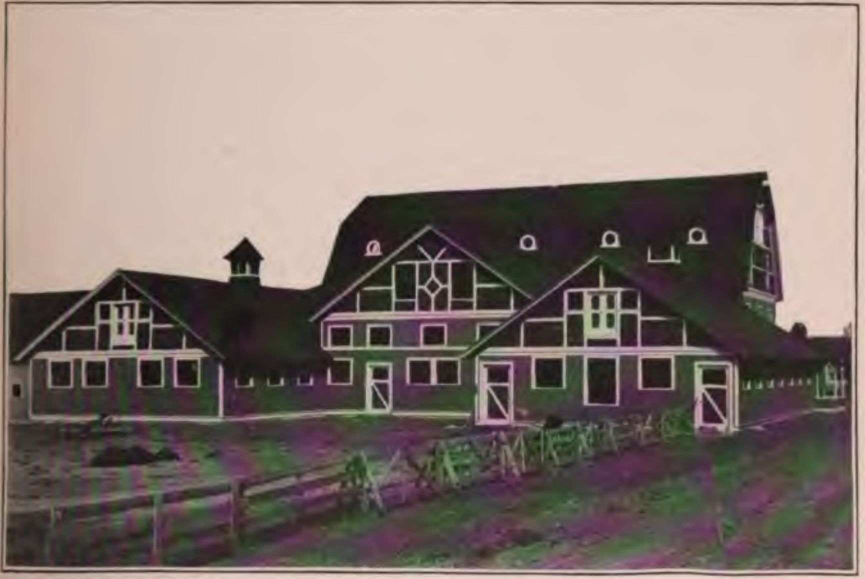

FIG. 2.—MONTANA STATION—REAR VIEW OF NEW CATTLE BARN.

production have attracted much attention and are being continued. Many problems in the care and feeding of hens and chickens are also being studied. Recently an experiment to determine the best use of floor space has been undertaken in cooperation with the Bureau of Animal Industry. The new curtain-front poultry house erected during the year (Pl. II, fig. 1) will be used in this work, as will also another similar building now being erected.

In addition to the nutrition, horticultural, and poultry work, there has been the usual inspection of fertilizers, feeding stuffs, seeds, and creamery glassware, also some work in entomology and quite extensive field experiments, especially with vegetables in cooperation with the Bureau of Plant Industry, and with potatoes. Experiments on the effect of the time of digging upon potatoes showing indications of rot, both as regards yield and keeping qualities, indicate that the late dug potatoes not only give a larger yield but keep better.

The director of the station has been relieved of college duties. The farm and horticultural plant, and all station buildings except the poultry plant and the laboratory office building, have been transferred to the university. The laboratory office building, which is now called Holmes Hall, has been enlarged, and changes in the arrangement of the rooms have been made in order to adapt it better to the uses of the station. These changes give the station better facilities and relieve it of all duties except the work of inspection and investigation.

The Maine Station continues to restrict its work to a few important lines, and is improving its facilities and segregating its work in such a way as to make it a much more effective agency for research in agriculture. At the same time it is gaining a better hold on the farmers of the State, as is indicated by the largely increased correspondence and the greater local demand for its publications. Its income, however, is so limited that it is compelled to defer many important investigations.

### LINES OF WORK.

The principal lines of work conducted at the Maine Station during the past year were as follows: Chemistry—study of feeding stuffs and various fertilizers and miscellaneous analytical work; botany; inspection of fertilizers, concentrated commercial feeding stuffs, seeds, and creamery glassware; horticulture—experiments in the selection, propagation, and improvement of blueberries, study of hardy fruits and vegetables; diseases of plants—fungus diseases of potatoes and other plants; food and nutrition of man and animals; poultry investigations—breeding and feeding experiments; diseases of animals; entomology; and dairying.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 1,576.18 |
| Fees | 4,525.00 |
| Balance from previous year | 120.86 |
| Total | 21,222.04 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Reports for 1902 and 1903 and Bulletins 92–103, including two reports on feeding-stuff inspection, two on fertilizer inspection, a report on finance and meteorology including an index for the bulletins issued in 1903, and bulletins on the following subjects: Poultry experiments in 1902; dandelions, hawkweeds, ginseng, and cankerworms; plant-house aleurodes; notes and experiments on the wheats and flours of Aroostook County; potato experiments in 1903; notes on the Angora goat; the preservation of hen manure; poultry management; and entire-wheat flour.

## MARYLAND.

### Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

#### GOVERNING BOARD.

Board of Trustees: Governor Edwin Warfield,* *Baltimore;* Gordon T. Atkinson, *Princess Anne;* Wm. Shepard Bryan, *Baltimore;* Murray Vandiver * (*State Treasurer*), *Havre de Grace;* Spencer Jones, *Rockville;* George Y. Everhart, *Dickeyville Station, Baltimore;* F. Carroll Goldsborough,* *Easton;* Richard S. Hill, *Marlboro;* Charles H. Stanley,* *Laurel;* E. G. Merryman, *Cockeysville;* Harold Walsh, *Upper Falls;* J. M. Monroe, *Annapolis;* Charles H. Evans, *Baltimore;* C. J. Purnell, *Snow Hill;* David Seibert,* *Clearspring;* Charles W. Slagle,* *Baltimore;* Charles A. Councilman,* *Glyndon.*

#### STATION STAFF.

H. J. Patterson, B. S., *Director; Chemist.*
J. S. Robinson, *Horticulturist.*
S. S. Buckley, D. V. S., *Veterinarian.*
W. T. L. Taliaferro, B. A., *Agronomist.*
C. F. Doane, M. S. AGR., *Dairy Husbandman and Bacteriologist.*
J. B. S. Norton, M. S., *Botanist, Vegetable Pathologist.*
E. O. Garner, *Superintendent of Farm, Recorder of Experiments.*
W. N. Hutt, B. S. A., *Horticulturist.*
T. B. Symons, M. S., *Acting Entomologist.*
A. B. Gahan, B. S., *Assistant Entomologist.*
F. H. Blodgett, M. S., *Assistant Plant Pathologist, Botanist.*
E. P. Walls, B. S., *Assistant Agronomist.*
J. R. Owens, M. D., *Treasurer.*
H. H. Howell, *Clerk.*
T. H. White, *Gardener.*

### GENERAL OUTLOOK.

There have been few changes in the work of the Maryland Station during the past year. The breeding experiments for the improvement of corn and alfalfa have been considerably broadened, and the chemist is cooperating in this work by making a study of the chemical composition of these crops. He is also studying the relative sweetness of different varieties of sweet corn to secure data for future experiments in breeding this crop to increase the sugar content. In the dairy division studies of the feeding value of alfalfa hay, corn silage, and cowpea silage, of the change in milk during the period of heat of cows, and of milk to determine the proper time during the milking period for making weighings and fat tests, have been completed. The horticulturist has undertaken some new work with varieties of cherries, a study of methods of pruning peaches, experiments with cover crops and in orchard cultivation, and with varieties of American and Japanese chestnuts and American and English walnuts, butternuts, hickory nuts, pecans, and filberts. The division of botany and plant pathology, in connection with its inspection work, is studying cabbage diseases, varieties of fruits and vegetables resistant to diseases, dust and liquid sprays, corn smuts, crown gall on apples, and types of tobacco. The division of entomology, in addition to work previously reported, has undertaken a series of experiments for controlling the root maggot of cabbage.

The station is cooperating with the Bureau of Plant Industry of this Department in its work with cereals and in experiments on truck crops. A few minor improvements on buildings have been made during the year. The associate horticulturist resigned to take charge of the horticultural work in the Cuban Experiment Station. There were also several minor changes in the personnel of the staff. Progress has been made during the year in more definitely organizing the work of the station along lines of investigation. The $5,000 appropriation from the legislature, which was available last year, has been a great aid to the station in broadening its investigations and in extending its influence by means of publications and correspondence.

### LINES OF WORK.

The principal lines of work conducted at the Maryland Station during the past year were as follows: Chemistry—analytical work, study of cereals, milk preservatives, baking powders, etc.; soils; field experiments—tests of varieties of grasses, forage crops, soil renovators, corn, potatoes, and wheat; cultural, fertilizer, and inoculation experiments; breeding and selection of corn and wheat; horticulture—orchard management, variety tests, cover crops, cultural methods, breeding and selection of strawberries and carnations, rotation of vegetables in the forcing house, systematic study of fruit areas in Maryland; diseases of plants; feeding experiments; dairying; diseases of animals; entomology—inspection of orchards, study of life history of injurious insects.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 5,000.00 |
| Farm products | 4,468.25 |
| Balance from previous year | 142.29 |
| Total | 24,610.54 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 89–93, the Annual Report for 1903, and four circulars. The subjects treated in the bulletins included experiments upon the use of potash as a fertilizer, experiments on the control of the San José scale, experiments with nitrogenous fertilizers, notes on apple culture, and second report on the cause of pithiness in celery.

## MASSACHUSETTS.

### Hatch Experiment Station of the Massachusetts Agricultural College, *Amherst.*

Department of the Massachusetts Agricultural College.

#### GOVERNING BOARD.

Board of Trustees: Governor John L. Bates (*ex-officio President*), *Boston;* W. R. Sessions (*Vice-President*), *Springfield;* G. F. Mills (*Treasurer*), *Amherst;* E. W. Wood,* *West Newton;* C. A. Gleason, *New Braintree;* James Draper,* *Worcester;* S. C. Damon,* *Lancaster;* M. I. Wheeler, *Great Barrington;* C. H. Preston, *Danvers;* G. H. Ellis, *Boston;* J. H. Demond, *Northampton;* E. D. Howe, *Marlboro;* N. I. Bowditch, *Framingham;* William Wheeler, *Concord;* M. F. Dickinson, *Boston;* H. H. Goodell * (*ex-officio*), *Amherst;* J. Lewis Ellsworth * (*Secretary*), *Boston;* Geo. H. Martin (*ex-fficio*), *Boston.*

### STATION STAFF.

Henry H. Goodell, LL. D., *Director.*
William P. Brooks, Ph. D., *Agriculturist.*
G. E. Stone, Ph. D., *Botanist.*
C. A. Goessmann, Ph. D., LL. D., *Chemist* (Fertilizers).
J. B. Lindsey, Ph. D., *Chemist* (Foods and Feeding).
C. H. Fernald, Ph. D., *Entomologist.*
F. A. Waugh, M. S., *Horticulturist.*
J. E. Ostrander., A. M.; C. E., *Meteorologist.*
H. T. Fernald, Ph. D., *Associate Entomologist.*
F. R. Church, B. S., *Assistant Agriculturist.*
N. F. Monahan, B. S., *Assistant Botanist.*
H. D. Haskins, B. S., *First Assistant Chemist* (Fertilizers).
Edward G. Proulx, B. S., *Second Assistant Chemist* (Fertilizers).
E. B. Holland, M. S., *First Chemist* (Foods and Feeding).
P. H. Smith, B. S., *Assistant Chemist* (Foods and Feeding).
E. S. Fulton, B. S., *Assistant Chemist* (Foods and Feeding).
Albert Parsons, B. S., *Inspector* (Foods and Feeding).
J. G. Cook, B. S., *Assistant in Foods and Feeding.*
G. O. Greene, M. S., *Assistant Horticulturist.*
G. W. Patch, *Observer.*
G. F. Mills, M. A., *Treasurer.*

### GENERAL OUTLOOK.

The work of the Massachusetts Station has been mainly a continuation of investigations previously inaugurated. During the year the botanist has summarized all of the work of his department on the subject of electricity as related to plant growth, involving eight years of investigations with about 40,000 plants. This work was awarded the Walker prize by the Boston Society of Natural History. The botanical department is also continuing the study of the effect of illuminating gas on plants, soil texture for roses, soil bacteriology, numerous diseases of plants, and atmospheric electricity as related to plant growth. For this latter work several greenhouses a few feet square were constructed and the air within charged with different amounts of electricity. Under these conditions crops of radishes and other plants were grown. Crops of radishes seemed to be much stimulated by the electricity.

The principal work of the horticultural department relates to the propagation of fruits, pruning, and the study of systematic pomology. The results have recently been published of a study of the union, or lack of union, between the stock and scion in grafting. It is shown that no such union takes place, but that the new wood grows around the scion. The agriculturist has continued his investigations as heretofore, and has recently done considerable work in testing material sent out by this Department for the inoculation of seeds of legumes, as compared with inoculation of the soil. The department of feeds and feeding is continuing its former lines of work and conducting a series of digestion experiments with sheep and feeding experiments with cows to determine the value of a variety of grain fodders. The inspection of fertilizers, feeding stuffs, and creamery glassware has been continued as heretofore with State funds.

A State forester was provided for by the last session of the legislature and has been appointed. He has no definite connection with the college, but will deliver some lectures, and is authorized to establish a forest nursery on the college grounds. The legislature made liberal appropriations to the college, including an increase for maintenance, and $500 a year for the printing of bulletins. The mailing list of the station now contains between 18,000 and 19,000 names, and many applications for publications are being received from public and normal schools outside of the State which can not be met.

The Massachusetts Station is covering a wide range in its investigations, and much of this is of a fundamental character and has a wide application in practice. The growth of the instructional work in the college, however, has made such demands upon the staff that in some instances they have been compelled to restrict their investigations. If the station is to maintain its high position as a research institution it must have additional funds for the employment of additional assistants.

### LINES OF WORK.

The principal lines of work conducted at the Massachusetts Station during the past year were as follows: Chemistry—miscellaneous analytical work, studies of legumes and plants affecting the quality of butter; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments—soil inoculation, plat experiments with fertilizers, grasses, and various farm crops, supplemented by similar pot experiments; horticulture—propagation of plants, pruning, systematic pomology; study of the effect of electricity and illuminating gas on plants and trees; diseases of plants, especially those of melons, cucumbers, and lettuce; digestion and feeding experiments; diseases of animals; entomology—study of the life history of economic insects and the use of insecticides; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 13,000.00 |
| Fees | 4,204.58 |
| Farm products | 2,714.79 |
| Miscellaneous, including balance from previous year | 6,805.48 |
| Total | 41,724.85 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 88–94, and Meteorological Bulletins 174–177 and 180–183. Bulletins 89, 90, and 95 are concerned with fertilizers and the analysis of manurial substances, and Bulletins 93 and 94 with concentrated feeds and distillery and brewery by-products. Bulletin 88 is a catalogue of the coccidæ of the world, and Bulletin 91 injuries to shade trees from electricity. There was also a technical bulletin (No. 1) on greenhouse aleurodes

## MICHIGAN.

### **Experiment Station of Michigan State Agricultural College,** *Agricultural College.*[a]

Department of Michigan State Agricultural College.

### GOVERNING BOARD.

State Board of Agriculture: C. J. Monroe (*President*), *South Haven;* Chas. F. Moore,* *St. Clair;* W. H. Wallace, *Bay Port;* Governor A. T. Bliss, *Lansing;* Jonathan L. Snyder (*President of the College*), *Agricultural College;* R. D. Graham, *Grand Rapids;* L. W. Watkins,* *Manchester;* A. P. Bliss, *Saginaw;* B. F. Davis (*Treasurer*), *Lansing.*

### STATION STAFF.

C. D. Smith, M. S., *Director; Agriculturist.*
L. R. Taft, M. S., *Horticulturist.*
R. S. Shaw, B. S. A., *Live Stock.*
R. H. Pettit, B. S. Agr., *Entomologist, Botanist.*
C. E. Marshall, Ph. D., *Bacteriologist.*
F. W. Robison, B. S., *Chemist.*
F. S. Kedzie, M. S., *Associate Chemist.*
G. A. Waterman, M. D. C., *Consulting Veterinarian.*
Mrs. L. E. Landon, *Librarian.*
T. A. Farrand, *in charge of Substation* (*South Haven*).
L. M. Geismar, *in charge of Substation* (*Chatham*).

### GENERAL OUTLOOK.

The principal development of work at the Michigan Station during the past year has been along lines of animal husbandry and bacteriology. In animal husbandry the general question of quality of meat and factors influencing it are being investigated. Studies are being made of the feeding value of corn in various forms for beef cattle; of dried beet pulp and beet pulp combined with molasses, as compared with corn and oil meal, in feeding sheep; and of soiling crops, especially a succotash of peas, oats, corn, rape, and millet, for pigs.

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[a] Freight and express address, *Lansing.*

The results indicate a high value for the beet sugar by-products. Experiments on the influence of wide and narrow rations on fine, coarse, and medium wool sheep (Rambouillets, Lincolns, and Shropshires) are in progress, as well as tests of the effect of feed on the quality of wool. Experiments in the breeding of a medium bacon hog are contemplated, and Duroc-Tamworth and Berkshire-Tamworth crosses have been made. A herd of grade dairy cows has been purchased and a study of the improvement of such animals by good care and crossing will be taken up. The fundamental idea underlying the experiments in animal husbandry is the determination of the factors which influence and control the quality of the product. The farm buildings are being relocated and rearranged on a systematic plan as fast as funds will permit.

The station is now well equipped for bacteriological work and has made notable progress in the study of dairy bacteriology. Special attention is being given to the associative action of milk bacteria. These investigations are being planned and prosecuted mainly with reference to their bearing on the general question of pure milk and dairy products. Studies of the bacteriology of soils and plants have been resumed and some studies of bacteriology as related to animal diseases and to domestic science have been taken up. The field work on the study of root tubercles of legumes has been continued and has brought out some interesting results as to the effects of fertilizers and previous cropping on the abundance and character of these tubers. It has also been found that inoculated legumes yield a much larger percentage of nitrogen than those which have not been inoculated.

There is also considerable work in agronomy, including a large amount of work with sugar beets. Some interesting results have been obtained in breeding wheat and corn for high gluten content, also in the study of winter wheat for Michigan, field selection of seed, exhaustion of soil moisture by weeds, soluble salts in soils, amount of plowing necessary for Michigan soils, and other similar problems. Considerable attention is being given by the veterinarian, bacteriologist, chemist, and director to the "Grand Traverse Disease" of cattle, the principal symptom of which is extreme emaciation, apparently due to a lack of certain ash elements in the feed.

The station is cooperating with this Department as follows: With the Bureau of Plant Industry in fiber investigations, experiments on truck crops, and growing sugar-beet seed; with the Bureau of Chemistry in studying the effect of environment on the chemical composition of sugar beets; and with the Bureau of Soils in a soil survey. There is also considerable cooperation with farmers in growing alfalfa, testing crops for the sandy regions of the State, and studying the influence of the soil on the quality of the wheat crop. The work at the South Haven and the Chatham substations has been continued, as heretofore, with State funds. During the year the botanist resigned to accept a similar position in Colorado, and his work has been taken up by the entomologist.

The Michigan Station is doing much useful work along lines of animal husbandry and bacteriology, and considerable work in dairying and agronomy. In these branches of agriculture it is not only attacking and helping to solve the current problems of the Michigan farmer, but is undertaking considerable original investigation. The horticultural work, however, which represents a very large investment in the State, is practically confined to inspection work, which is paid for by the State, and to tests of varieties of orchard and small fruits and vegetables. There are some studies of diseases and insect pests of fruits by the botanist and entomologist, but no very comprehensive horticultural investigations. This work should be developed, and the State, which contributed to the station during the past year only for printing and for the support of substations ($5,000 for the Upper Peninsula Substation and $500 for the horticultural substation at South Haven), could well afford to provide liberal funds for this purpose.

### LINES OF WORK.

The principal lines of work conducted at the Michigan Station during the past year were as follows: Chemistry—analysis and control of fertilizers and feeding stuffs, analysis of breakfast foods and condiments; bacteriology—aeration of milk, its effect on gases, souring, etc.; study of milk supply and the bacteria of the dairy; soils; field experiments—fertilizer, cultural and variety tests with sugar beets and many other field crops, production of sugar-beet seed, rotation, experiments with cowpeas, soy beans, and other legumes, breeding and selection of wheat; horticulture—variety tests and orchard management; diseases of plants—fungus diseases of the sugar beet, clover, and fruits; feeding experiments—utilization of cowpeas, soy beans, and other legumes, comparison of corn silage with dried corn fodder and with beet pulp, fattening lambs with beet pulp; diseases of animals; entomology; and stable hygiene.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | [a] 5,500.00 |
| Fees | 2,140.00 |
| Farm products | 2,376.73 |
| Miscellaneous, including balance from previous year | 3,799.25 |
| Total | 28,815.98 |

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[a] For substations.

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 209–212, on the following subjects: Vegetables and bush fruits, fertilizer analyses, breakfast foods, and seed testing for farmers; Special Bulletins 20–25, report of the Upper Peninsula Substation for the years 1901 and 1902, cheese problems, the crop of corn, a preliminary note on the associative action of bacteria in the souring of milk and in other milk fermentations, insects injurious to fruits in Michigan, and fungus diseases of fruits in Michigan; and the Annual Report for 1903, which contains the annual financial statement, brief accounts of the work of the year in different departments, a summary of meteorological observations for 1902, and the bulletins issued by the station during the year.

## MINNESOTA.

### **Agricultural Experiment Station of the University of Minnesota,** *St. Anthony Park, St. Paul.*

Department of the University of Minnesota.

### GOVERNING BOARD.

Board of Regents: Greenleaf Clark (*President*), *St. Paul;* William M. Liggett, *St. Anthony Park;* Stephen Mahoney (*Secretary*), *Minneapolis;* Elmer E. Adams, *Fergus Falls;* Thomas Wilson, *St. Paul;* A. E. Rice, *Willmar;* O. C. Strickler, *New Ulm;* James T. Wyman, *Minneapolis;* Governor Samuel R. Van Sant, *Winona;* Cyrus Northrop, *Minneapolis;* John W. Olsen, *Albert Lea;* Jos. E. Ware, *St. Anthony Falls Bank* (*Treasurer*), *Minneapolis;* Eugene W. Randall, *Morris.*

### STATION STAFF.

William M. Liggett, *Director.*
Willet M. Hays, M. Agr., *Agriculturist.*
Samuel B. Green, B. S., *Horticulturist.*
Harry Snyder, B. S., *Chemist.*
T. L. Haecker, *Dairy Husbandman.*
M. H. Reynolds, M. D., D. V. M., *Veterinarian.*
E. L. Washburn, A. M., *Entomologist.*
Andrew Boss, *Animal Husbandman.*
T. A. Hoverstad, B. Agr., B. S., *Superintendent of Substation* (*Crookston*).
A. J. McGuire, B. Agr., *Superintendent of Substation* (*Grand Rapids*).
J. A. Hummel, B. Agr., *Assistant Chemist.*
C. P. Bull, B. Agr., *Assistant Agriculturist.*
A. G. Ruggles, B. S. A., M. A., *Assistant Entomologist.*
L. B. Bassett, *Farm Foreman.*
J. A. Vye, *Secretary.*

### GENERAL OUTLOOK.

The general character of the work of the Minnesota Station remains the same as heretofore, but it has been marked by steady and wholesome development in all departments. The plant-breeding work now includes not only the cereals but also peas, cowpeas, soy beans, and other legumes, forage crops, and fiber plants. This work, as well as experiments with truck crops and studies of the influence of origin of red-clover seed on the yield of crop, is conducted largely in cooperation with the Bureau of Plant Industry of this Department. The station has also continued to cooperate with the Bureau of Statistics in collecting statistics relating to the cost of growing field crops and to farm management, and with this Office in nutrition investigations. In addition to the nutrition investigations the chemist of the station has in hand a number of studies along other lines which are of much interest and importance He is selecting and growing starchy and glutinous wheats in boxes to see if the quality is transmitted, studying the digestive action of skim milk in rations for pigs, also the influence of grinding grains upon digestibility, the influence on digestibility of watering horses before and after meals, determining the plant food in seeds of cereals, and studying soil fertility and the nutrition of plants by leachings of fertile soil. The veterinarian is conducting an interesting experiment in ventilation, keeping steers shut up tight without fresh air, or with only a limited supply, and testing the blood corpuscles to determine the effect. Steers were kept in tight rooms without ventilation for 40 days with very little effect on the blood corpuscles. One steer gained a pound a day for 40 days under these conditions. The entomologist has been working on the leaf hopper on nursery stock, and has devised a 4-row spraying machine which sprays above and below at the same time. The State gives $5,000 a year for the State entomologist's work, and the nurserymen of the State pay for the nursery inspection. In animal husbandry one of the new lines of work is the development of a system of individual feeding.

A new live-stock building which will cost from $33,000 to $35,000 has been completed. This will be used largely for stock judging and for housing temporarily the animals which are used for that purpose, but will also contain offices to be used by the station. An administrative building, which will provide quarters for the department of agronomy, is also to be constructed out of the $300,000 appropriation made by the legislature last year.

The Minnesota Station is investigating a wide range of subjects of great importance to the agriculture of the State and to the whole Northwest. Its investigations with cereals, forage crops, and fiber plants have yielded many valuable results. In 1899 the station distributed a Fife wheat, and in 1902 a Blue Stem, which is sold at a high price for seed. It is estimated that 300,000 acres of the Fife wheat developed by this station were grown the past year in Minnesota and the Dakotas, at an increased return of approximately $1 an acre. The Premost flax, which was also developed at this station, is proving valuable because of its heavy yield of seed. The station's economic studies, in cooperation with this Department, also give promise of valuable results. In this work three men are kept in the field, and go about among the farmers estimating the cost of labor, machinery, etc., in producing field crops, also the cost of feeding and handling cattle. The results of the first year's work in this line have been tabulated and given to the Bureau of Statistics for publication. The evident monetary value of much of the work done by this station makes it very popular throughout the State, and as a result the station is receiving liberal support and sharing in the prosperity of the school and college with which it is connected.

### LINES OF WORK.

The principal lines of work conducted at the Minnesota Station during the past year were as follows: Chemistry of soils and farm crops; field experiments—rotations, tests of varieties of cereals and forage crops, time and depth of seeding grains and amount of seed, methods of seeding grasses; horticulture—tests of varieties of fruits and vegetables, use of wind-breaks, testing hardy stocks for apple trees, improvement of native fruits; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying; farm management, and farm statistics.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation, including substations | 35,362.88 |
| Farm products, including substations | 10,205.74 |
| Total | 60,568.62 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 82–86, on the following subjects: Hemorrhagic septicemia, apples and apple growing in Minnesota, injurious insects of 1903, wheat and flour investigations, and the food value of sugar.

# MISSISSIPPI.

## Mississippi Agricultural Experiment Station, *Agricultural College.*[a]

Department of Mississippi Agricultural and Mechanical College.

### GOVERNING BOARD.

Board of Trustees: Governor J. K. Vardaman (*President ex officio*), *Jackson;* A. J. Moore (*Secretary*) *Agricultural College;* W. J. Miller (*Treasurer*), *Jackson;* F. L. Hogan,* *Starkville;* T. L. Wainwright, *Stonewall;* T. C. Dockery, *Love Station;* J. T. Harrison, *Columbus;* W. C. George, *Greenwood;* W. H. Morgan,*[b] *Sheppardtown;* W. A. Dickson, *Centerville;* Henry L. Whitfield, *Jackson;* A. T. Dent, *Macon;* J. W. Norment, *Starkville;* J. C. Hardy*[b] (*President of the College*), *Agricultural College.*

### STATION STAFF.

W. L. Hutchinson,*[b] M. S., *Director; Chemist.*
E. B. Ferris, M. S., *Assistant Director in charge of McNeill Substation.*
E. R. Lloyd, M. S., *Assistant Director; Agriculturist.*
G. W. Herrick, B. S. A., *Botanist, Entomologist.*
A. B. McKay, B. S., *Horticulturist.*
J. C. Robert, V. M. D., *Veterinarian.*
W. R. Perkins, M. S., *Associate Chemist.*
J. S. Moore, M. S., *Dairy Husbandman.*
A. J. Moore, B. S., *Treasurer.*
John Phares, *Foreman of McNeill Substation.*
Maude Butler, *Stenographer.*
R. N. Crane, *Poultryman.*

### GENERAL OUTLOOK.

The Mississippi Station continues to devote its attention mainly to animal production, dairying, and the improvement of soils, with closely related experiments in producing home-grown forage. Experiments with poultry have been added during the past year, which include studies of varieties of fowls, incubation, and the production of broilers. A small plant for this work has been constructed and a poultryman has been appointed. The experiments in beef production thus far have shown a profit from the production of "stockers" and "feeders," but the finishing of scrub stock has not been found profitable. Finishing experiments, however, are to be made with stock grown by the station, and it is believed that better results may be obtained with these. The size of the dairy herd has been increased and now contains pure-bred Jersey, Shorthorn, and Red Polled cows, the last two breeds being used to test the value of the dual-purpose cow for Mississippi. The work in agronomy is supplementary to that in animal husbandry and is conducted largely by the former associate chemist, who has been made assistant to the agriculturist and put in charge of this work. The entomologist is devoting much of his time to work in connection with the cotton-boll weevil quarantine, cooperating in this work with the Bureau of Entomology of this Department. The station is also cooperating with the Bureau of Plant

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[a] Telegraph address, *Starkville.* Express and post-office address, *Agricultural College.* Freight address, *A. and M. College Station.*

[b] In charge of the management of McNeill Substation.

Industry in diversification of farm work and with the Bureau of Soils in a soil survey.

The work of the substation at McNeill has been very successful and there is a great demand for an increase in the number of such substations. The last legislature of the State appropriated $14,000 for the McNeill Substation for the next two years, and also provided for the establishment of two other branch stations, giving $3,000 for each, with the understanding that the communities in which the stations are located shall contribute the necessary land. One of these substations has been located at Holly Springs, in the brown-loam region, and the other at Stoneville, in the Delta region. On July 24, 1904, the station building at McNeill was struck by lightning and destroyed with all its contents.

Several of the departments of the main station are well equipped with offices and laboratories in the new agricultural building of the college. The station building proper has been moved and remodeled to some extent, and a new greenhouse has been built, which also contains an insectary for the use of the entomologist. Progress has been made in concentrating the farm work. The work in animal production, agronomy, and horticulture has been grouped together and assigned a definite farm area, while the experiments in dairy husbandry, veterinary science, and poultry culture occupy separate areas. There is need of further differentiation of college and station work and of investigations along a number of new lines. The latter, however, will not be possible until the station is given funds more nearly commensurate with the importance of agriculture in the State.

### LINES OF WORK.

The principal lines of work conducted by the Mississippi Station during the past year were as follows: Soils—restoring and maintaining fertility, study of artesian waters, methods of preventing erosion, and restoring washed soils; fertilizers; field experiments—growing pasturage and forage crops, testing varieties of wheat, oats, and cotton; horticulture; animal husbandry—beef production, combined with swine and sheep production, and poultry culture; dairying; diseases of animals—Texas fever and other diseases; entomology—boll weevil, chicken mite, and insects affecting the leading garden and farm products.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation for substations | 20,000.00 |
| Farm products | 2,062.07 |
| Miscellaneous, including balance from previous year | 225.85 |
| Total | 37,287.92 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 81, on the Colorado potato beetle, and the Annual Report of the station for 1903, the latter including an account of the work at the McNeill Substation.

## MISSOURI.

### **Missouri Agricultural College Experiment Station,** *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

### GOVERNING BOARD.

Board of Curators: John D. Vincil (*President*), *St. Louis;* Gardiner Lathrop, (*Vice-President*), *Kansas City;* J. G. Babb (*Secretary*), *Columbia;* R. B. Price (*Treasurer*), *Columbia;* C. B. Faris, *Caruthersville;* Campbell Wells,* *Platte City;* Walter Williams,* *Columbia;* Joseph Hansen, *St. Joseph;* D. A. McMillan, *Mexico;* Archibald McVey, *Chillicothe;* B. G. Thurman, *Lamar.*

### STATION STAFF.

H. J. Waters,[a] B. S. A., *Director.*
F. B. Mumford, M. S., *Acting Director; Animal Breeding.*
Paul Schweitzer, Ph. D., LL. D., *Chemist.*
J. C. Whitten, M. S., Ph. D., *Horticulturist.*
J. M. Stedman, B. S., *Entomologist.*
G. I. Reeves, B. S., *Assistant Entomologist.*
J. W. Connaway,[a] M. D. C., M. D., *Veterinarian.*
C. H. Eckles,[a] M. S., *Dairying.*
E. B. Forbes, B. S., *Animal Husbandman.*
M. F. Miller, M. S. A., *Agronomist.*
W. L. Howard, M. S., *Assistant Horticulturist.*
B. M. Duggar, Ph. D., *Botanist.*
H. S. Reed, A. B., *Assistant Botanist.*
R. M. Bird, Ph. D., *Acting Chemist.*
E. H. Favor, B. A., *Assistant Horticulturist.*
M. W. Harper, M. S., *Assistant in Feeding.*
A. E. Grantham, A. B., *Assistant Agronomist.*
John Schnabel, *Gardener.*
J. G. Babb, M. A., *Secretary.*
R. B. Price, *Treasurer.*
Estelle Hickok, *Clerk, Stenographer.*

### GENERAL OUTLOOK.

The principal investigations of the Missouri Station continue to be along lines in animal husbandry and horticulture, as outlined in the last report of this Office. At the same time some new phases of work in these lines are being investigated, and work along other lines is being started. The veterinarian is studying the relation between

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[a] On leave.

Texas fever and the "ranilla" disease of Mexico, and has begun preliminary studies on contagious abortion, hog cholera, and other diseases. The entomologist is studying a number of insects, and has recently published a bulletin on the work of the plum curculio on apples. The botanist is cooperating with the horticulturist in studies on crown gall and other diseases, and is giving considerable attention to mushroom culture. He has perfected a method of preparing pure mushroom spawn on a commercial scale.

The station is cooperating with the Bureau of Plant Industry of this Department in variety tests of vegetables, study of alfalfa, forage crops for the production of beef cattle, and diseases of orchard fruits; and with this Office in irrigation investigations. It is also conducting a large number of experiments in cooperation with farmers to test fertilizers for corn and in growing alfalfa under different conditions, as well as with several other stations in experimenting with northern and home-grown seeds. Station officers have taken an active part in farmers' institutes, have lectured before teachers' meetings and high schools, and have prepared a number of bulletins for teachers. The facilities of the station for investigations have been considerably improved during the past year through the appointment of four additional instructors, who relieve station men of considerable teaching; by the erection of a $2,500 feeding shed, 300 by 30 feet, and the addition of other equipment. There is a State appropriation of $15,000 for a new veterinary laboratory, and new sheep and cattle barns are in process of erection. The director of the station has been absent on leave during the year to take charge of the Missouri agricultural exhibit at the Louisiana Purchase Exposition, and his duties have fallen upon the acting director.

The general condition of the Missouri Station is very satisfactory. It is receiving very liberal treatment from the university and is thus enabled to strengthen its staff and improve its facilities for investigation. It is the policy of the station to concentrate its work along a few lines, giving greatest prominence to cattle feeding and fruit raising, on account of their great importance in the State. This is a wise policy, owing to the fact that the funds available for the use of the station are still very small in proportion to the rural wealth of the State.

### LINES OF WORK.

The principal lines of work conducted at the Missouri Station during the past year were as follows: Chemistry—inspection of fertilizers, study of food adulterants and fungicides; botany—mushroom culture; field experiments—cereal and forage crops, fertilizers, rotations, renovating worn-out soils; horticulture—experiments with apples, plums, grapes, peaches, pears, small fruits, and nuts, breeding experiments with fruits, diseases of apples; animal breeding; feeding experiments with beef cattle, sheep, and swine; diseases of animals; entomology—study of ticks on cattle, parasites of sheep, and insects affecting fruits; dairying; and drainage and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15, 000. 00 |
| State appropriation | 3, 000. 00 |
| Fees | 4, 323. 09 |
| Farm products | 3, 124. 41 |
| Balance from previous year | 178. 29 |
| Total | 25, 625. 79 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 61–63 and Annual Reports for 1899, 1900, 1901, 1902, and 1903. The subjects of the bulletins are apple growing in Missouri, the Hessian fly in Missouri, and commercial fertilizers. The Annual Report for 1903 contains, in addition to the usual material of an administrative nature, the following special articles: Investigations of the bodies called fiber and carbohydrates in feeding stuffs, with a tentative determination of the components of each; adulterated linseed oil for veterinary purposes; and an investigation of canned food products.

## **Missouri State Fruit Experiment Station,** *Mountain Grove.*

### GOVERNING BOARD.

Trustees: C. B. McAfee (*President*), *Springfield;* T. M. Culver (*Secretary*), *Koshkonong;* Joe Knoerle (*Treasurer*), *West Plains.*

### STATION STAFF.

Paul Evans, *Director.*
Frank Horsfall, B. S., *Assistant Horticulturist.*
F. W. Faurot, B. S., *Assistant in Investigation of Plant Diseases.*
A. M. Swartwout, *Field Assistant.*

### GENERAL OUTLOOK.

The work of the Missouri State Fruit Experiment Station has been continued as heretofore under appropriations from the State. Attention has been given mainly to the development of orchards and other fruit plantations, and such practical work as the testing and improvement of varieties. The bulletins issued during the year have consisted mainly of compilations and records of observations on the above work.

### LINES OF WORK.

The principal lines of work conducted at the Missouri State Fruit Experiment Station during the past year were as follows: Horticulture—experiments with fertilizers and cover crops for orchards; breeding experiments with apples, peaches, and strawberries; orchard survey; tests of new land for orchard purposes; study of crown gall, bitter rot, root rot, and other diseases affecting fruits; experiments and studies of injurious insects; experiments with insecticides and fungicides, and inspection of orchards and nurseries.

### INCOME.

The station is supported entirely by State appropriations, the amount for the years 1903 and 1904 being $32,000. Of this sum $21,259.61 was available for the year 1904.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 7–10 on strawberry culture, commercial orchards of south Missouri, fruit buds, and orchard enemies.

## MONTANA.

### Montana Agricultural Experiment Station, *Bozeman.*

Department of the Montana College of Agriculture and Mechanic Arts.

#### GOVERNING BOARD.

Executive Board: Walter S. Hartman (*President*), *Bozeman;* Peter Koch (*Secretary and Treasurer*), *Bozeman;* John Maxey, *Bozeman;* John M. Robinson, *Bozeman;* E. B. Lamme, *Bozeman.*

#### STATION STAFF.

F. B. Linfield, B. S. A., *Director; Agriculturist, Animal Husbandman.*
V. K. Chesnut, B. S., *Chemist.*
J. S. Baker, B. S., *Irrigation Engineer.*
R. W. Fisher, B. S., *Horticulturist.*
Edmund Burke, *Assistant Chemist.*
J. W. Blankinship, Ph. D., *Botanist.*
Robt. A. Cooley, B. S., *Zoologist.*
W. J. Elliott, B. S. A., *Assistant Dairyman.*
Alfred Atkinson, B. S. A., *Assistant Agronomist.*
Herbert J. Reese, B. S., *Assistant Chemist.*
James Dryden, *Poultryman, Clerk.*

#### GENERAL OUTLOOK.

Few changes have been made during the past fiscal year in the work of the Montana Station. The work on pure foods and sugar beets is completed; that with poisonous plants has been continued in cooperation with the Bureau of Plant Industry of this Department.

Drug-plant investigations and experiments with truck crops have been taken up in cooperation with the Bureau of Plant Industry. Irrigation investigations in cooperation with this Office have been continued and extended, including some work with farmers, and a hydrographic survey of the small streams of the State has been undertaken in cooperation with the State irrigation engineer. The horticulturist is endeavoring to develop a variety of apples adapted to the region. The entomologist is working on the bud moth, and has continued the experiments for the extermination of grasshoppers. He has had good results this year with the Criddle mixture, which is composed of 1 part of Paris green, 2 parts of salt, and from 40 to 100 parts of horse manure. There is also some work with bees.

The director who was on leave has definitely severed his connection with the station, and the agriculturist has been made director. An irrigation engineer, a poultryman, and an assistant agronomist have been appointed. Farmers' institutes have been in charge of the director, and have been attended by nearly every member of the station staff. There is a State appropriation of $4,000 for this work.

Much progress has been made during the year toward the improvement of the station equipment and facilities for work. With a State appropriation of $16,000 for buildings during the last biennium the station has erected a seed barn and granary costing $2,100, a cattle barn costing $13,000 (Pl. II, fig. 2), an implement shed, a bee house, a piggery, and additions to the poultry house and dairy building, besides moving other buildings and making additions to the equipment of some of the laboratories. It also receives from the State now an annual maintenance fund of $5,000.

The station has made a good showing during the past year in systematizing its work and in improving its facilities by the erection of a number of farm buildings. The feeling toward the station throughout the State is excellent, as is shown by the appropriations made for it. It is having a very marked influence on the development of agriculture in the State and on the introduction of improved and more rational methods of farm management.

## LINES OF WORK.

The principal lines of work conducted at the Montana Station during the past year were as follows: Chemistry—study of alkali soils, alkali limit of plant growth, poisonous plants, effect of various rotations on soils, sugar-beet investigations, food inspection, and miscellaneous analytical work; meteorology; botany—study of plants utilized by Indians, and other systematic work; field experiments—rotations, improvement of cereals, cooperative sugar-beet tests, test of grasses and forage crops; horticulture—orchard and small fruits and forest trees; feeding experiments—cattle and sheep; poultry experiments; entomology—codling moth, bud moth, grasshoppers, and other insects affecting fruits, vegetables, and shade trees; dairying; irrigation—duty of water, losses by evaporation, seepage, methods of application, study of water rights, and plant and pot experiments to determine the water requirements of plants and methods of application.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 24,011.71 |
| Farm products | 3,871.02 |
| Total | 42,882.73 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 45–51, on the following subjects: The loco and some other poisonous plants in Montana, two insect pests, sheep feeding, steer feeding, contagious abortion in Montana, poultry management and poultry diseases, and the first annual report of the State entomologist of Montana.

## NEBRASKA.

### **Agricultural Experiment Station of Nebraska,** *Lincoln.*

Department of the University of Nebraska.

#### GOVERNING BOARD.

Regents of the University: John L. Teeters (*President*), *Lincoln;* Carl J. Ernst, *Omaha;* Elisha C. Calkins,* *Kearney;* Edson P. Rich,* *Omaha;* Charles S. Allen, *Lincoln;* William G. Whitmore,* *Valley;* James S. Dales (*Secretary*), *Lincoln.*

#### STATION STAFF.

E. A. Burnett, B. S., *Director; Animal Husbandman.*
T. L. Lyon, Ph. D., *Associate Director; Agriculturist.*
C. E. Bessey, Ph. D., LL. D., *Botanist.*
Lawrence Bruner, B. S., *Entomologist.*
E. H. Barbour, Ph. D., *Geologist.*
A. T. Peters, D. V. M., *Animal Pathologist.*
G. D. Swezey, M. A., *Meteorologist.*
O. V. P. Stout, C. E., *Irrigation Engineer.*
Samuel Avery, Ph. D., *Chemist.*
R. A. Emerson, B. S., *Horticulturist.*
A. L. Haecker, B. S. A., *Dairy Husbandman.*
H. R. Smith, B. S., *Animal Husbandman.*
J. H. Gain, M. D. C., *Assistant Animal Pathologist.*
W. P. Snyder, *Superintendent of North Platte Substation.*
S. W. Perin, *Farm Foreman.*
J. S. Dales, Ph. M., *Financial Secretary.*
W. W. Marshall, *Executive Clerk.*

### GENERAL OUTLOOK.

The Nebraska Station has given prominence to two groups of investigation—agronomy and animal husbandry. The work in agronomy is very extensive, involving, as it does, plat and field experiments covering 75 acres; cooperative experiments with 1,700 farmers on the improvement of winter wheat, corn, and oats; cooperative experiments with the Bureau of Plant Industry of this Department on cereal investigations, and work in cooperation with the chemist of the station on the chemical composition of different breeds of corn and wheat. Breeding investigations to produce varieties of corn, wheat, and forage crops having certain well-defined qualities—e. g., high or low protein, oil, or starch content of corn or wheat; alfalfa with large leaves which will not fall off easily in curing, etc.—are in various stages of progress. During the year the station published, as a result of the work in agronomy, bulletins on sugar beets, Kherson oats, variety tests of corn, and pasture, meadow and forage crops. In animal husbandry the station is conducting feeding experiments with cows, steers, calves, and pigs to test different feeds and methods of feeding, both for maintenance and for fattening.

Tests are being made of Pintsch gas by-products for dips, insecticides, fungicides, disinfectants, and as a poison for prairie dogs. The veterinarian is continuing work on the cornstalk disease, studying the influence of different feeds upon the strength of bones in its possible relation to lameness of horses, and is trying to determine how the ox warble fly reaches the animal. There is considerable horticultural work, including orchard work, spraying, breeding and selection of beans, and work on truck crops in cooperation with the Bureau of Plant Industry. The station is also cooperating with the Bureau of Entomology in an investigation of grasshopper conditions in various States, and with this Office on irrigation investigations.

Considerable progress has been made in erecting the buildings provided for by the last legislature. The $12,000 dairy barn and the $7,000 horticultural building and greenhouse have been completed, and the $60,000 building for the school of agriculture is nearing completion. The $15,000 appropriation for the substation at North Platte is being utilized in acquiring land, erecting buildings, and inaugurating investigations for the semiarid parts of the State.

As a result of liberal treatment by the State and the university, the Nebraska Station is acquiring much better facilities for investigations, and is enabled to carry on a large amount of work which is of great importance to the agriculture of the State. It is hoped that this liberal attitude will be continued in order that the station may keep pace with the rapid progress of agriculture in that region.

### LINES OF WORK.

The principal lines of work conducted at the Nebraska Station during the past year were as follows: Chemistry, botany, meteorology; soils—sources of moisture, moisture as affected by different crops, aeration, and fertilization; field experiments—rotations, breeding experiments, grasses and legumes, sugar beets, winter wheat, corn, soy beans, and imported grains; horticulture—development of hardy varieties of fruits by hybridization, grafting, and selection, and breeding of beans; diseases of plants; forestry; feeding and breeding experiments; diseases of animals—cholera in hogs, dysentery in calves, abortion, mange, sorghum poisoning, cornstalk disease; dairying; entomology—grasshopper fungus disease, chinch-bug disease; extermination of prairie dogs with Pintsch gas by-products; irrigation—records of water used on different crops, methods of cultivation, and records of discharge of several rivers.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products, including balance from previous year | 7,537.76 |
| Total | 22,537.76 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 80–84, on the following subjects: Experiments in mulching green vegetables, experiments in the culture of the sugar beet in Nebraska, Kherson oats, cooperative variety tests of corn in 1902 and 1903, and pasture, meadow, and forage crops.

## NEVADA.

### **Nevada Agricultural Experiment Station,** *Reno.*

Department of Nevada State University.

### GOVERNING BOARD.

Regents of University: John E. Bray, *Reno;* W. W. Booher, *Elko;* Richard Kirman (*President*), *Reno;* George H. Taylor (*Secretary*), *Reno;* O. J. Smith, *Reno;* H. S. Starrett, *Battle Mountain.*

### STATION STAFF.

Joseph E. Stubbs, M. A., D. D., *Director.*
Nathaniel E. Wilson, M. S., *Vice-Director; Chemist.*
Peter Fransden, A. M., *Zoologist, Bacteriologist.*
P. B. Kennedy, PH. D., *Botanist, Horticulturist.*
G. H. True, B. S., *Agriculturist, Animal Husbandman.*
Carolyn M. Beckwith, *Stenographer and Librarian.*
S. B. Doten, B. A., *Entomologist.*
C. R. Fitzmaurice, *Assistant Chemist.*
Theodore W. Clark, *Farm Foreman.*

### GENERAL OUTLOOK.

The work of the Nevada Station has changed very little during the past year. The principal development of work has been in animal husbandry, botany, and horticulture. A small dairy herd of Holsteins has been secured, and a record is kept of its feed, and its milk and butter production. Experiments were begun with swine, but these were interrupted by an outbreak of plague. As soon as additional animals are secured experiments on the economy of pork production will be undertaken. Some work in crossing Dorset and range sheep has been commenced. The general objects of the animal-husbandry work are to study the economy of production with the feeds available in the State and to encourage the improvement of farm stock. There have also been tests of forage plants and cover crops, and of experimental plantations of fruit, forest, and ornamental trees. The station is cooperating with the Bureau of Animal Industry of this Department in experiments with drug plants, and is making a study of methods of irrigation and the water requirements of different crops for the State board of irrigation in cooperation with this Office. The collection of Nevada plants, including poisonous plants and a chemical study of the same, has been continued, and range investigations, including the study of winter conditions on the range, are contemplated. The study of the nature, habits, and treatment of the ground squirrel has been completed. There is considerable cooperation with farmers in testing varieties of small fruits, feeding tests to determine the value of different native hays and to determine the desirability of supplementing alfalfa with other feeding stuffs in feeding dairy cows. Farmers' institutes were conducted during the year in a number of places and were quite successful.

The equipment of the station and the funds available for investigations are far from adequate. The farm is in fairly good condition for experimental work and considerable live stock has been secured, but there are no farm buildings, except the foreman's cottage, and the station is compelled to use some of the sheds on the State fair grounds adjacent to the farm. The income of the station is practically limited to the Hatch fund, and after the payment of salaries and other administrative expenses very little is left to pay the expenses of investigations. There is urgent need of State aid sufficiently liberal to enable the station to improve its equipment and to organize its work on a broader and more efficient basis.

### LINES OF WORK.

The principal lines of work conducted at the Nevada Station during the past year were as follows: Chemistry; botany—studies of poisonous plants and of range plants eaten by sheep; soils; field experiments—tests of varieties of wheat, grasses, and other forage plants; horticulture; forestry; animal diseases—hog cholera, anthrax, and big head of sheep; entomology; and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 712.04 |
| Balance from previous year | 155.94 |
| Total | 15,867.98 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 55–57, on summer ranges of eastern Nevada sheep, the western cricket, and grasshoppers in alfalfa fields; and the Annual Report for 1903.

## NEW HAMPSHIRE.

**New Hampshire College Agricultural Experiment Station,** *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

### GOVERNING BOARD.

Board of Trustees: Governor Nathum J. Bachelder (*President*), *Concord;* G. A. Wason,* *New Boston;* W. M. Parker (*Treasurer*), *Manchester;* W. D. Gibbs* (*ex officio*), *Durham;* C. W. Stone,* *East Andover;* Lucien Thompson (*Secretary*), *Durham;* J. G. Tallant,* *Pembroke;* Harry E. Barnard, *Concord;* G. B. Williams, *Walpole;* Warren Brown,* *Hampton Falls;* R. W. Pillsbury, *Londonderry;* R. M. Scammon, *Stratham;* Walter Drew, *Colebrook;* G. B. Chandler, *Manchester.*

### STATION STAFF.

W. D. Gibbs, M. S., *Director.*
F. W. Morse, M. S., *Vice-Director, Chemist.*
F. W. Rane, B. AGR., M. S., *Horticulturist.*
F. W. Taylor, B. S., *Agriculturist.*
E. D. Sanderson, B. S. A., *Entomologist.*
I. C. Weld, *Dairy Manufactures.*
E. L. Shaw, B. S., *Associate Agriculturist.*
H. F. Hall, *Associate Horticulturist.*
J. C. Bridwell, B. S., *Assistant Entomologist.*
H. D. Batchelor, B. S., *Assistant Chemist.*
Edith M. Davis, *Purchasing Agent.*
Mabel H. Mehaffey, *Stenographer.*

### GENERAL OUTLOOK.

A very complete reorganization of the New Hampshire Station has been effected under the new director, and in most departments there has been a readjustment of work. The entomologist has resigned to take charge of nature-study work in the public schools of Lowell, Mass., and is succeeded by E. D. Sanderson, of the Texas College and Station. There has also been a change in the position of assistant chemist. Aside from these changes the officers are the same as those in charge a year ago. The facilities for experiments and instruction in horticulture have been greatly increased by the completion of new greenhouses, with a legislative appropriation of $7,000.

The greenhouse work in forcing vegetables has been, and continues to be, a prominent feature of the investigations at this station. There is also important work in cross pollination with melons, tomatoes, potatoes, peppers, and other vegetables, supplemented by field experiments with a large number of crops. The horticulturist also has some work in progress with roses, carnations, and other flowers, and has started a forest nursery, studying especially methods of growing trees from seed and the utilization of waste land for forest growth. The cold storage of apples is also being investigated.

In agricultural lines there have been experiments in feeding pigs and calves, and variety tests and cultural experiments with oats, corn, and forage crops. Feeding experiments with horses to determine the comparative feeding value of light and heavy grades of oats have recently been undertaken. The chemist has cooperated with the agriculturist in making analyses of feeding stuffs, has made a study of the respiration of stored apples, and begun a systematic study of the available fertility in the various soils of the college farm. He has also had inspection work with fertilizers and feeding stuffs. The station is testing milk for farmers in the effort to maintain the legal standard of total solids and fat. The entomological work consists largely of inspection and a study of the distribution, habits, and methods of control of the brown-tail moth.

The station now has much better facilities for work than ever before, and a staff of workers who are prosecuting their investigations with vigor. It is, therefore, in position to render efficient aid to the agriculture of the State and to extend its investigations as rapidly as funds are supplied for this purpose.

### LINES OF WORK.

The principal lines of work conducted at the New Hampshire Station during the past year were as follows: Chemistry—study of soils and of yield of dry matter and digestible nutrients in feeding stuffs and analysis of fertilizers and feeding stuffs; field experiments—cultural experiments and variety tests of oats, corn, and forage crops; horticulture—tests of varieties of muskmelons, potatoes, strawberries, tomatoes, and other fruits and vegetables, experiments in breeding and forcing vegetables, and renovation of old orchards; forestry; feeding experiments; entomology—suppression of insect pests, and a study of the life zones of the principal insects of the State; dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Fees | 1,129.21 |
| Total | 16,129.21 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 102–111, including the Annual Report for 1903, and other bulletins on the following subjects: Insect record for 1902; standard milk; Fifteenth Annual Report, 1903; fruit growing, with a selected list of varieties for New Hampshire; forestry; the browntail moth in New Hampshire; inspection of fertilizers in 1903; the pernicious or San José scale insect in New Hampshire; experiments in orchard management in New England, and ten experiments with potatoes and potato culture for New England.

## NEW JERSEY.

### **New Jersey State Agricultural Experiment Station,** *New Brunswick.*

At Rutgers College.

### GOVERNING BOARD.

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### STATION STAFF.

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## **New Jersey Agricultural College Experiment Station**, *New Brunswick.*

Department of Rutgers College.

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### STATION STAFF.

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Julius Nelson, Ph. D., *Biologist.*
Byron D. Halsted, D. Sc., *Botanist, Horticulturist.*
Irving S. Upson, M. A., *Disbursing Clerk, Librarian.*
John B. Smith, D. Sc., *Entomologist.*
Jacob K. Shaw, B. S. Agr., *Field Assistant.*
Earle J. Owen, B. S., *Field Assistant.*
Augusta E. Meske, *Stenographer and Typewriter.*

### GENERAL OUTLOOK.

The principal development of the work of the New Jersey stations during the past fiscal year has been along the lines of greater efficiency in the investigations already established. The study of means for eradicating the mosquito pest, which has been continued since 1902 with a special State appropriation of $10,000, ends this year. The results of this investigation are such as to warrant the station in urging upon the authorities of the State a plan for a systematic eradication of the mosquito. Much interest has been taken in this work, not only by the authorities in many States in this country, but by those of foreign countries. The work of the entomologist on sprays for San José scale resulted in a practical failure of the lime-sulphur-salt wash on peaches and pears this year, while the use of crude oil gave good results.

The studies on the improvement of soils, especially those concerned with soil bacteriology, are of great importance. Studies are being made of nitrogen assimilation in the soil by means of nonsymbiotic bacteria. The bacteriologist finds these widely distributed over the country. He has discovered a new form of bacteria which assimilates nitrogen more rapidly than Beijerinck's; and has discovered that bacteria may assimilate nitrogen without being in symbiotic relations with other bacteria, which Beijerinck said was impossible. The soil conditions he finds have much to do with their action, and this points toward the important relation which culture has to fertility, and the reason of it. The stations have recently commenced cooperating with farmers in studying the question of forage crops on the light soils of the State, and methods of improving soils by means of inoculation and the growing of leguminous plants. They have continued to cooperate with this Office in irrigation investigations, and have begun experiments on truck crops in cooperation with the Bureau of Plant Industry of this Department. The last legislature increased the appropriation for the State Station from $19,500 to $24,500. There is also a State appropriation of $3,000 for nursery inspection which is turned over to the station. The repairs to the station laboratory building necessitated by the fire are nearly completed. The station library is now housed in a new $50,000 college library building.

The New Jersey stations continue to stand in close relation to the farmers and horticulturists of the State and enjoy the hearty moral and financial support of their constituents. The ease with which they secure the appropriations necessary for their work is an indication of the high degree of confidence which these stations enjoy. They are aggressive in attacking questions of local importance, and at the same time are carrying on several lines of investigation of high scientific value.

### LINES OF WORK.

The principal lines of work conducted at the New Jersey stations during the past year were as follows: Chemistry—study of adulterants of feeding stuffs, chemical composition and relative value of the various kinds of lime used in the State, methods of examining insecticides, studies of the losses of nitrogen in barnyard manures; biology—oyster culture; botany—breeding of corn, beans, and tomatoes; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments—forage crops, soiling crops, experiments with fertilizers and garden crops, experiments with barnyard manures; horticulture—cultural experiments with orchard and small fruits, ornamentals and vegetables, cross fertilization of eggplants, sweet corn, cucumbers, and tomatoes; diseases affecting beans, potatoes, sweet potatoes, and other garden vegetables; diseases of animals; entomology—study of mosquitoes and methods of eradicating them, study of the rose scale, orchard insects, and the use of insecticides; dairy husbandry—breeding up a dairy herd, study of domestic pasteurizing methods and the care of milk in the home, feeding dairy cows, including the investigation of legumes as substitutes for purchased feeds; bacteria of soils, and irrigation.

### INCOME.

The income of the stations during the past fiscal year was as follows:

| | |
|---|---|
| State Station: State appropriation (fiscal year ended October 31, 1904) | [a] $26,000 |
| College Station: United States appropriation | 15,000 |
| Total | 41,000 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of these stations received during the past fiscal year were Bulletins 164–171, including the following subjects: Field experiments with nitrate of soda on forage crops and on market garden crops, concentrated feeding stuffs, the proper disposal of sewage wastes in rural districts, some of the newer fungicides, analyses of commercial fertilizers, insecticides and their uses, experiments in crossing sweet corn, and the common mosquitoes of New Jersey.

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[a] Including special appropriation for mosquito investigation.

## NEW MEXICO.

### **Agricultural Experiment Station of New Mexico,** *Mesilla Park.*

Department of New Mexico College of Agriculture and Mechanic Arts.

#### GOVERNING BOARD.

Board of Regents: Granville A. Richardson (*President*), *Roswell;* H. B. Holt (*Secretary and Treasurer*), *Las Cruces;* Seaman Field, *Deming;* Jose Lucero, *Las Cruces;* J. M. Webster, *Hillsboro.* Advisory Members: Gov. Miguel A. Otero, *Santa Fe;* J. Francisco Chaves (*Superintendent of Public Instruction*), *Santa Fe.*

#### STATION STAFF.

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John J. Vernon, M. S. AGR., *Agriculturist.*
E. O. Wooton, A. M., *Botanist.*
John D. Tinsley, B. S., *Vice-Director; Soils, Meteorologist.*
Fabian Garcia, B. S., *Horticulturist.*
John M. Scott, B. S., *Assistant Animal Husbandman.*
R. Fred Hare, M. S., *Chemist.*
F. O. Woodruff, A. M., *Assistant Chemist.*
A. E. Lovett, B. S., *Assistant in Irrigation.*
Francis E. Lester, *Registrar.*
J. O. Miller, B. S., *Assistant Registrar.*
Pinckney Ford, *Stenographer.*

#### GENERAL OUTLOOK.

As heretofore, the work of the New Mexico Station during the past fiscal year has centered around irrigation, especial attention being given to pumping—methods, cost, economy. The profitableness of this method of securing water for irrigation in this region seems to depend mainly upon the cost and efficiency of fuel, which is scarce. The various available fuels are being tested, as well as different forms of engines, pumps, and other apparatus, and the size of bores. As a source of supply for supplementing gravity irrigation on high-value crops the economy of pumped water seems assured. Whether it will be profitable as the sole source of supply for general extensive farming remains to be demonstrated. The pumping plant of the station is proving of great value in the experimental work in providing an adequate supply of water at all seasons, whereas formerly the river supply, which was the sole reliance, frequently proved inadequate at critical periods of drought. Onions have been raised at the station at a net profit of $500 per acre with water pumped at a cost of $15 per acre. The cost and net returns with other crops are being studied. Irrigation investigations are being conducted in cooperation with this Office.

There have also been studies of range and grazing problems and experiments with truck crops in cooperation with the Bureau of Plant Industry of this Department, feeding experiments with dairy cows and beef steers, chemical studies, investigations of soils, including alkali and drainage. The studies of soil moisture and methods of irrigation have involved many new methods and necessitated the devising of new pieces of apparatus. Members of the staff have participated in farmers' institute work, but at a considerable disadvantage owing to the high cost of travel. Exhibits of photographs, equipment, apparatus, and herbarium specimens were made at St. Louis. A number of changes in the staff of the agricultural and chemical departments have occurred, but all positions are now filled.

The New Mexico Station is making considerable improvement in the organization of its staff and in securing equipment suited to its needs, and it has in hand a large amount of important work. However, it is still much hampered by lack of facilities and funds in some of its departments. The act appropriating $25,000 for college buildings has been declared unconstitutional, and the tax levy which was expected to yield $15,000 has given only $11,200. The station is attracting increased attention among the farmers of the Territory, who are making demands on it which can not be met until more liberal funds are provided.

### LINES OF WORK.

The principal lines of work conducted at the New Mexico Station during the past year were as follows: Chemistry—chemical survey of the waters of the Territory, analytical work, study of the ash of native plants; field experiments—alfalfa, grasses for lawns and pastures, cereals, soil renovators, forage crops; soils; feeding experiments with dairy cows, steers, and sheep to test the value of various grains and forage crops for soiling and for dry feed; horticulture—culture, pruning, spraying, and irrigation of orchard, vineyard, and small fruits, vegetable culture, tests of shrubs, flowers, and forest trees; botany—range problems; entomology; and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 1,827.61 |
| Miscellaneous | 250.00 |
| Total | 17,077.61 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 44–50. These include two reports on soil-moisture investigations, and the following other bulletins: Ash analyses of some New Mexico plants, pumping for irrigation from wells, canaigre, shade trees and other ornamentals, and steer and lamb feeding.

## NEW YORK.

### New York Agricultural Experiment Station, *Geneva.*

#### GOVERNING BOARD.

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#### STATION STAFF.

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W. P. Wheeler, *Animal Industry.*
H. A. Harding, M. S., *Bacteriologist.*
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N. O. Booth, B. Agr., *Assistant Horticulturist.*
O. M. Taylor, *Foreman in Horticulture.*
F. A. Sirrine,[a] M. S., *Special Agent.*
F. E. Newton, *Clerk and Stenographer.*
Jennie Terwilliger, *Clerk and Stenographer.*
Julia E. Hoey, *Junior Clerk.*
A. H. Horton, *Computer.*

#### GENERAL OUTLOOK.

The New York State Station has made good progress during the past year, and has published a number of bulletins of great value to agriculture. Among the investigations which have been closed or have yielded results worthy of publication are the following: Study of chemical changes in the souring of milk and their application to the manufacture of cottage cheese, resulting in a process whereby excellent cottage cheese may be made from fresh milk within half an hour; studies on the chemical changes in the home-making of cider vinegar; experiments in thinning apples, showing the process to be of doubtful utility except in case of very heavy setting of fruit or where choice fruit can be made to command an extra price; experiments in shading strawberries, resulting generally in poor fruit and decreased yield; tests of apples in storage; investigations of gas formation in canned peas, the trouble found to be due to the action of bacteria and successfully prevented by processing the cans at

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[a] Riverhead, N. Y.

240° F. for thirty minutes; study of the effect of mineral nutrients in poultry feeding, showing the very great utility of grit and a free supply of other mineral matter for young chicks; experiments in spraying potatoes, with very profitable gains from the process both in the station tests and in cooperation with farmers; tests of fall spraying with sulphur washes, which can be safely applied in the fall on hardy varieties of fruit trees.

The station has inaugurated considerable new work, including among other things a study of the applicability of specific gravity as a test in seed selection, a study of the distribution in the soil of the germs of plant diseases, classification of the flora of Cheddar cheese, experiments in the use of bulky and succulent vegetable feeds for poultry, tests of the sulphur wash as applied to insects other than the San José scale and as a fungicide, and tests of some new forage crops, especially on light soils. In studying the causes of mottled butter it has been found that this condition is apparently due to the action of salt on the casein compounds, which shrink under the action of the salt. The station is also continuing a study of the metabolism of phosphorus in the cow. The results already obtained indicate quite a marked relation between the presence of phosphorus in the ration and the production of fat. The percentage of fat fell from 3.6 to 2.2 when the bran compound containing the phosphorus was removed from the ration, but the yield of milk increased, although not sufficiently to keep up the yield of total fat.

Cooperative experiments with farmers have been continued on a larger scale than formerly. These have included tests of potato spraying, with profit in almost every case; tests of the use of lime and of inoculation in the introduction of alfalfa, the use of lime giving marked results in many instances and the inoculation in a few cases; tests of different stocks for American grapes and of dwarf stocks for apples; tests of the sod-mulch system *v.* the system of tillage and cover crops in managing apple orchards; and experiments with commercial fertilizers in orchards. The investigation of cabbage diseases in cooperation with farmers and with the Vermont Station have been continued, as have also the sugar-beet experiments in cooperation with this Department. Experiments on trucking crops have been undertaken in cooperation with the Bureau of Plant Industry. The inspection work with fertilizers, feeding stuffs, Paris green, insecticides, and creamery glassware have been continued. The fertilizer law has been so changed as to make the commissioner of agriculture responsible for the prosecution of fraudulent cases. The station has completed the rebuilding of its barns and outbuildings, which were destroyed by fire, and now has an excellent equipment in this line.

The New York State Station continues to occupy a prominent position among the best of our agricultural stations. It has a very efficient corps of workers, and is pursuing the policy of conducting work of highly scientific character, combined with a considerable amount of work of immediate practical importance and application. This policy is giving the station wide recognition as an institution for higher investigation, and at the same time in maintaining the interest of the farmers of the State, and helping them to answer the important practical problems that lie at their doors. It is furnishing a good illustration of the important results which may come from liberal financial support of a station in enabling it to solve the problems of practical importance to agriculture, and at the same time to conduct investigations of a deeper scientific significance which advance the cause of agricultural science and promote the investigation work of the experiment stations as a whole.

### LINES OF WORK.

The principal lines of work conducted at the New York State Station during the past year were as follows: Chemistry—study of problems in cheese ripening, of changes in milk, and of fertilizers and feeding stuffs; bacteriology—study of problems in cheese ripening, of gas formation in canned peas, tests of methods for the repression of rusty spot in cheese; meteorology; fertilizers—study of the proportions and forms of fertilizing ingredients best suited to the staple crops of the State; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments—tests of commercial fertilizers and stable manure on crops in rotation, study of crops grown on soils treated with crude chemicals, and cooperative tests of forage and soil-renovating crops, variety tests of cowpeas and wheat, growth of mother beets to test the possibility of raising sugar-beet seed; horticulture—study of the cause and effect of self-sterility among grapes, effect of fertilizers on the quality of strawberries and bush fruits, tests of various stocks for native grapes and for dwarf apples, comparison of American and Japanese chestnuts, use of screens for shading strawberries, experiments with apples in cold storage, breeding of grapes, raspberries, currants, gooseberries, and strawberries, test of lettuce fertilizers in the greenhouse, systems of management in apple orchards, collection of data to determine the significance of correlation of parts as a factor in plant breeding; diseases of plants—investigations and experiments in the treatment of raspberry and blackberry diseases, especially cane blight, study of diseases of apples, ten-year test of the efficiency of spraying potatoes to prevent disease and to increase yield, test of repressive measures for black rot of cabbage and cauliflower, with investigation of soft rot of the same plants, study of Rhizoctonia as a cause of plant diseases; feeding experiments; poultry experiments—study of the effect and value of different classes of nutrients in poultry feeding and of inbreeding and selection as affecting egg production; entomology—biological study of the San José scale and the development of a successful and convenient method for controlling this insect, experiments on the fertilization of fruit by bees, study of the economic relations of Dactylopius; dairying; and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $1,500.00 |
| State appropriation, including balance from previous year | 76,352.86 |
| Total | 77,852.86 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 233–252, and the Annual Report for 1902. The subjects treated in these bulletins are as follows: Rennet enzym as a factor in cheese ripening; experiments in curing cheese at different temperatures (with popular edition); two decays of stored apples (with popular edition); conditions affecting chemical changes in cheese ripening; the rôle of lactic-acid bacteria in the manufacture and in the early stages of ripening of Cheddar cheese; the status of phosphorus in certain food materials and animal by-products, with special reference to the presence of inorganic forms; thinning apples (with popular edition); some changes in a ripening cheese (popular edition of Bulletins 214, 215, 219, 231, 236, and 237); inspection of feeding stuffs; the importance of mineral matter and the value of grit for chicks; common diseases and insects injurious to fruits; potato-spraying experiments in 1903 (with popular edition); spray mixtures and spray machinery; chemical changes in the souring of milk and their relation to cottage cheese (with popular edition); an experiment in shading strawberries (with popular edition); the lime-sulphur-soda wash for orchard treatment (with popular edition); a swelling of canned peas accompanied by malodorous decomposition (with popular edition); director's report for 1903; the nature of the principal phosphorus compounds in wheat bran; and a report of analyses of commercial fertilizers for the spring and fall of 1903.

## **Cornell University Agricultural Experiment Station,** *Ithaca.*

Department of Cornell University.

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### STATION STAFF.

L. H. Bailey, M. S., *Director.*
John H. Comstock, B. S., *Entomologist.*
H. H. Wing, M. S. Agr., *Animal Husbandman.*
G. F. Atkinson, Ph. B., *Botanist.*
John Craig, M. S. Agr., *Horticulturist.*
T. F. Hunt, M. S., D. Agr., *Agronomist.*
R. A. Pearson, M. S. Agr., *Dairy Industry.*
Jay A. Bonsteel, Ph. D., *Soil Investigations.*
Mark V. Slingerland, B. S. Agr., *Entomologist.*
G. W. Cavanaugh, B. S., *Chemist.*
J. E. Rice, B. S. Agr., *Poultry Husbandman.*
J. L. Stone, B. S. Agr., *Assistant Agronomist.*
Samuel Fraser, *Assistant Agronomist.*
H. H. Whetzel, A. B., *Assistant Plant Pathologist.*
John W. Gilmore, B. S. A., *Assistant Agronomist.*
J. A. Bizzell, Ph. D., *Assistant Chemist.*
S. W. Fletcher, Ph. D., *Assistant Horticulturist.*
John M. Trueman, B. S. Agr., *Assistant Animal Husbandman, Dairy Industry.*
Chas. E. Hunn, *Assistant Horticulturist.*

### GENERAL OUTLOOK.

The past year has been largely one of reorganization at the Cornell Station. In the department of agronomy much time has been devoted to getting the new farms in shape for investigation. A large amount of work in breeding timothy has been started. About 12,000 seedlings grown from seed secured from different parts of this country, Europe, Australia, and other foreign countries have been transplanted

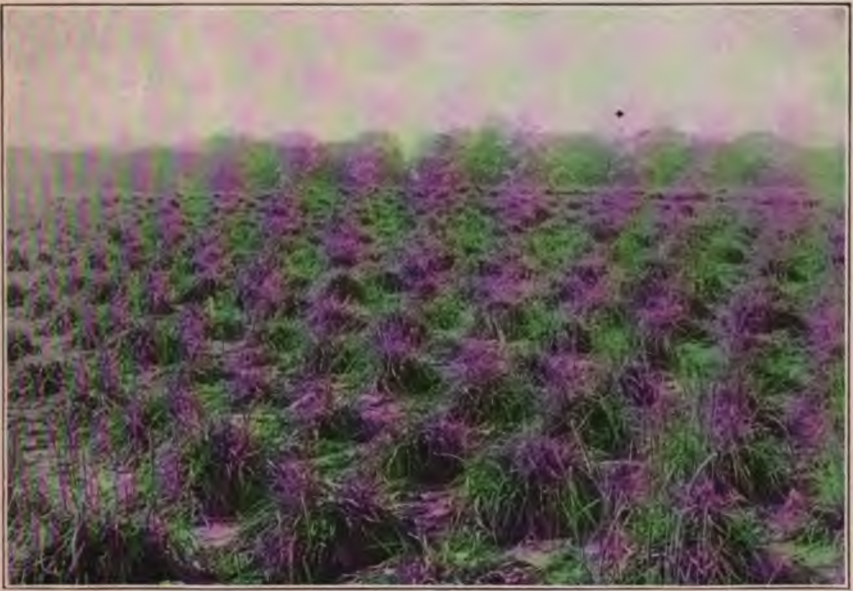

FIG. 1.—TIMOTHY BREEDING PLATS AT CORNELL STATION.

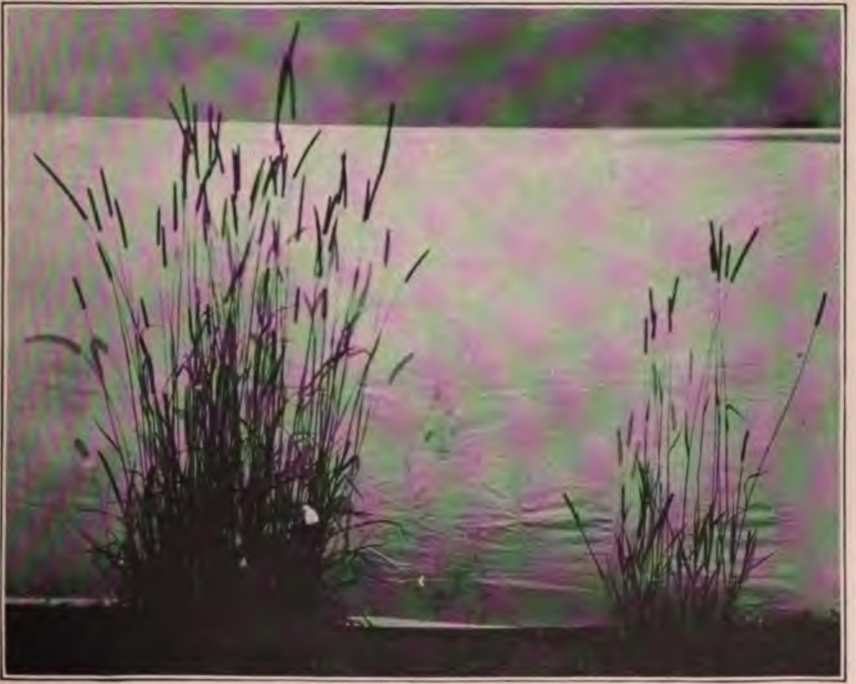

FIG. 2.—TIMOTHY PLANTS, SHOWING VARIATION DUE LARGELY TO SEED SELECTION.

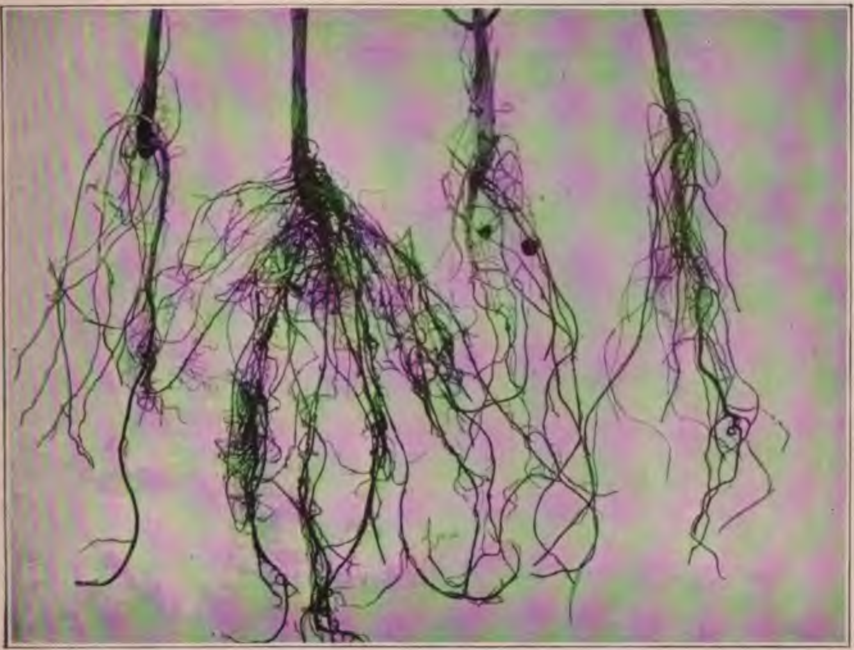

FIG. 1.—CORNELL STATION—COWPEA ROOTS, SHOWING IMPERFECT INOCULATION FIRST YEAR.

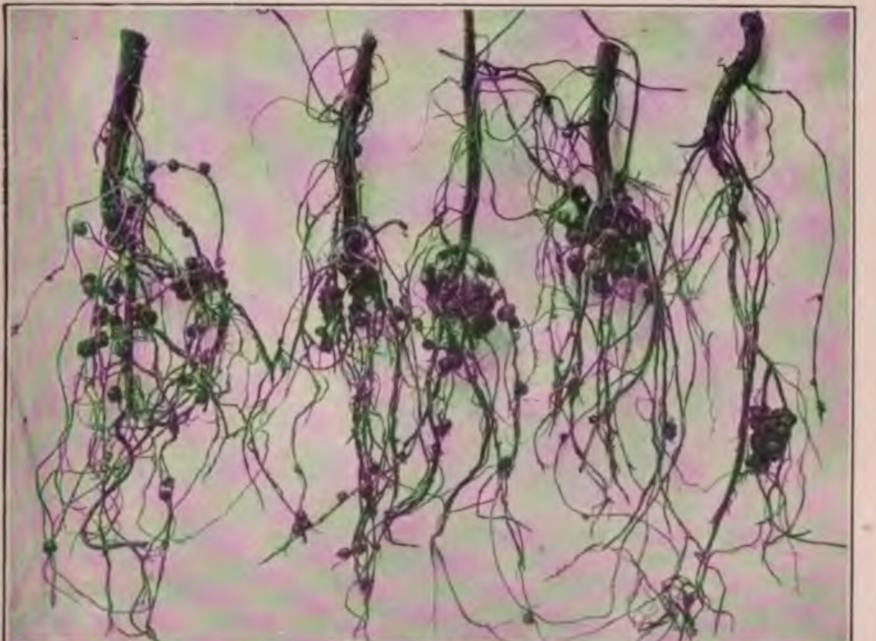

FIG. 2.—COWPEA ROOTS FROM SAME FIELD, SHOWING ABUNDANT TUBERCLES SECOND YEAR.

from the greenhouses to hills 2½ feet apart, and already show great variations (Pl. III). Work has also been started in breeding roots of different kinds, testing different ways of seeding alfalfa, inoculating soil (Pl. IV), utilizing manure, etc. In animal husbandry the studies on the effect of improved feed and care on the production of milk and fat have been closed. Experiments in economic beef production will now be taken up. The horticultural work includes a continuation of experiments in forcing vegetables, spraying, and studies of new fruits, and some new work in growing vegetables under shade and in the greenhouse. The horticulturist is also largely engaged in cooperation with the soil expert and the Bureau of Soils of this Department in making surveys of orchards with reference to soil conditions and the yield of fruit. The chemist has continued to cooperate with the Bureau of Chemistry of this Department in studying the effect of environment on the chemical composition of sugar beets, and will take up in cooperation with the agronomist of the station and a canning factory studies of the effect of selection on the sugar content of sweet corn. He plans also to make a chemical study of alfalfa soils. The entomologist has continued his studies on the most troublesome insects of the State, especially those affecting grapes. He has found a remedy for the berry moth, a new and troublesome insect of the grape, and is studying now a new maggot which works in the bud of grapes and causes them to fall off. The poultry investigations will include studies of the effect of warm houses, cost of egg production, and other economic problems. The poultry department has been very much enlarged and new buildings have been erected for its accommodation.

The extension work of the college of agriculture has been continued as heretofore, but it is now recognized as a department of college work clearly distinct from that of investigation. The present director recognizes three departments in the college of agriculture, viz, the experiment station, as the department of investigation; the four-year college course and the special courses, as the department of instruction; and the short courses, nature-study courses, demonstration work, and other popular work, as the department of extension. Much progress has been made during the year in organizing the work of these different departments, providing new equipment, and employing additional specialists for the different lines of instruction and investigation. The last legislature appropriated $250,000 for the college of agriculture. This will be devoted largely to the erection of new agricultural buildings on a portion of the old farm, in front of the farm barn and adjacent to the veterinary college. With these liberal funds for the development of the agricultural work, with a much stronger organization than ever before, and with a clearer distinction between the station work and that of the other departments of the college of agriculture, the outlook for the work of investigation at the Cornell Station is very bright.

### LINES OF WORK.

The principal lines of work conducted at the Cornell Station during the past year were as follows: Chemistry—study of soils, sugar content of beets and sweet corn, feeding stuffs, dairy products, insecticides; fertilizers; field experiments—tests of rotations, legumes, and fertilizers, tillage and fertilizer experiments with potatoes, beans, buckwheat, etc., plat experiments with grasses; horticulture—forcing strawberries, tree fruits, and mushrooms, studies of Japanese plums and methods of spraying; diseases of plants—fungus diseases of forest and shade trees, study of the rôle of fungi in rendering available the plant food in dead wood, study of edible fungi and of numerous fungus and bacterial diseases of vegetables; feeding experiments—dairy cows, sheep, and swine; diseases of animals; poultry experiments—crossing of breeds, experiments in the cost of egg production and on the effect of early molting on laying in the early fall and winter; entomology—study of the life history of several economic insects, spraying experiments; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $13,500.00 |
| State appropriation | [a]23,333.34 |
| Total | 36,833.34 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 211–218, and the Annual Report for 1903. The subjects of the bulletins are cooperative poultry experiments—the yearly records of three flocks, second report on cooperative records of the cost of producing eggs, methods of milking, the ribbed cocoon maker of the apple, the grape leaf hopper, spraying experiments, spray calendar, and onion blight.

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[a] Estimated amount of State and other appropriations, not included in Hatch fund, spent for experimental purposes.

## NORTH CAROLINA.

### **North Carolina Agricultural Experiment Station,** *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

S. L. Patterson, *Commissioner of Agriculture (Chairman), Raleigh;* T. K. Bruner (*Secretary, ex officio*), *Raleigh.*

Board of Agriculture: John M. Forehand, *Rockyhock;* J. B. Stokes, *Windsor;* Wm. Dunn, *Newbern;* C. N. Allen, *Auburn;* R. W. Scott, *Melville;* A. T. McCallum, *Red Springs;* J. P. McRae, *Laurinburg;* R. L. Doughton, *Laurel Springs;* W. A. Graham, *Machpelah;* A. Cannon, *Horseshoe.*

Board of Visitors: W. S. Primrose (*President*), *Raleigh;* R. L. Smith (*Secretary*), *Albemarle;* D. A. Tompkins, *Charlotte;* Frank Wood, *Edenton;* E. M. Koonce, *Jacksonville;* W. H. Ragan, *High Point;* David Clark, *Charlotte;* George Howard, *Tarboro;* W. J. Peele, *Raleigh;* J. Frank Ray, *Franklin;* Chas. W. Gold, *Wilson;* S. L. Patterson (*Commissioner of Agriculture, ex officio*), *Raleigh;* Geo. T. Winston (*President of College, ex officio*), *Raleigh.*

STATION STAFF.

B. W. Kilgore, M. S., *Director.*
W. A. Withers, A. M., *Chemist.*
C. W. Burkett, M. S., PH. D., *Agriculturist.*
W. F. Massey, C. E., *Horticulturist.*
Tait Butler, V. S., *Veterinarian.*
F. Sherman, jr., B. S. A., *Entomologist.*
F. L. Stevens, M. S., PH. D., *Biologist.*
C. Walker, PH. D., *Assistant Chemist.*
J. C. Kendall, B. S., *Assistant in Dairying.*
J. S. Jeffrey, *Poultryman.*
B. S. Skinner, *Farm Superintendent.*
B. F. Walton, *Superintendent of Agricultural Experimental Work.*
Gordon M. Bentley, M. A., *Assistant Entomologist.*
A. F. Bowen, *Bursar.*

GENERAL OUTLOOK.

The North Carolina Station has made satisfactory progress along the lines indicated in the last report of this Office. The college and station farm work has been separated, and for the station a system of between 600 and 700 permanent plats, ranging from one-fortieth to one-tenth acre each, has been established. On these the rotation, fertilizer, cultivation, adaptation, and variety testing experiments will be carried on. Considerable work with live stock has been started, cattle feeding for milk production being made a permanent feature of the investigation. An attempt is being made to build up a good dairy herd, the expense of which will be paid from college funds and the sale of milk. A preliminary bulletin has been issued on the feeding experiments with horses and mules, which have been in progress for about two years. The results so far obtained with the 59 rations tested indicate that the forage crops grown in North Carolina are well adapted to the feeding of horses and mules, and being available for every farmer it is unnecessary to purchase feeding stuffs outside of the State. On the new college farm 165 acres are being devoted to farm management, the attempt being to clear and improve the farm and bring the soil up to a good condition by means of rotations, including a liberal use of legumes, and to meet the expenses with receipts from the sale of products. The veterinarian is directing his efforts largely toward the eradication of ticks by removing cattle from infested pastures. As a result of his efforts two or three counties were officially declared free from ticks during the past year.

The biologist is continuing investigations on tobacco wilt, and has undertaken similar investigations on the cotton wilt and watermelon wilt in cooperation with the Bureau of Plant Industry of this Department. An attempt is also being made to secure resistant varieties of cotton and watermelons. The station is cooperating also with the Bureau of Chemistry on the effect of environment on the chemical composition of sugar beets, and with the Bureau of Soils in a soil survey. The cooperation between the station and the State department of agriculture continues to be harmonious and effective. The three experimental farms are still maintained by the department of agriculture, which is continuing its experiments with cotton, corn, peanuts, tobacco, grain, and forage plants at no expense to the station. Horticultural investigations are being started in a similar manner, special attention being given to truck crops and orchard fruits. The inspection work of the veterinarian and entomologist is largely carried on with funds from the State department of agriculture. The facilities for poultry investigations have been considerably improved during the year, and are to be further improved by the erection of new poultry houses. A new agricultural building for the college and station is now being erected. This has been located on high ground somewhat apart from the other college buildings where there is room for a group of agricultural buildings which will be erected in the near future. The main building now under way will cost in the vicinity of $80,000 and will be ready for occupancy by the beginning of the next college year. Farmers' institute work has been successfully prosecuted during the year by the college, the station, and the department of agriculture, the latter bearing all expenses aside from salaries. There has also been a large amount of work by the agriculturist in connection with the teachers' institutes throughout the State.

The staff of the North Carolina Station are doing a large amount of work for the improvement of agricultural conditions throughout the State. Much of this work is of a preliminary nature, but is fundamental to the improvement of conditions as they now exist. Such, for instance, are the cultural experiments, the variety tests to secure resistant crops, the experiments with legumes as soil correctives, the experiments in dairy management, and, in general, most of the work in farm management. The station already has a large amount of work started, and this will necessarily increase with the growth of the institution. The members of the staff are already crowded with work owing to the increasing number of students, and the demands upon them for lectures at farmers' institutes and for other extension work are such that it is very important that arrangements be made by which the heads of departments will be able to devote themselves effectively to the station work. The crusade that the station, the college, and the State department of agriculture are making for agricultural education and the improvement of rural conditions is having a marked effect, and is arousing much interest among the people of the State. Its continuance will necessarily make it very important that the work of research shall be clearly differentiated from that of instruction and that members of the station staff shall be relieved of duties as teachers and lecturers.

### LINES OF WORK.

The principal lines of work conducted at the North Carolina Station during the past year were as follows: Chemistry—rate of nitrification of different nitrogenous substances in different soils, methods of analysis; soils; field experiments—variety, cultural, and fertilizer tests with cotton, corn and cowpeas, experiments with grasses and forage plants; horticulture; plant diseases—wilt of tobacco and melons; animal husbandry—beef production, feeding work horses; diseases of animals; poultry experiments; dairying, and tests of farm machinery.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | [a]5,000.00 |
| Farm products | 2,195.77 |
| Total | 22,195.77 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 184–189 on the following subjects: The culture and marketing of orchard and garden fruits; the black rot of the grape in

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[a] Estimated amount of State appropriation spent for experimental purposes.

North Carolina and its treatment; insect and fungus enemies of the peach, plum, cherry, fig, and persimmon; the culture of grapes and small fruits; the Granville tobacco wilt—a preliminary bulletin; and feeding farm horses and mules.

## NORTH DAKOTA.

### **North Dakota Agricultural Experiment Station,** *Agricultural College.*[a]

Department of North Dakota Agricultural College.

#### GOVERNING BOARD.

Board of Trustees: Alex. Stern (*President*), *Fargo;* G. S. Barnes, *Fargo;* Maynard Crane, *Cooperstown;* B. N. Stone, *Lamoure;* S. S. Lyon (*Secretary*), *Fargo;* Addison Leach, *Warren;* Chas. McKissick, *Mayville;* L. B. Hanna (*Treasurer*), *Fargo.*

#### STATION STAFF.

J. H. Worst, LL. D., *Director.*
E. F. Ladd, B. S., *Chemist.*
C. B. Waldron, B. S., *Horticulturist, Entomologist.*
H. L. Bolley, M. S., *Botanist.*
J. H. Shepperd, M. S. A., *Agriculturist.*
J. C. McDowell, B. S. A., *Assistant Agriculturist.*
C. D. Holley, M. S., *Assistant Chemist.*
L. R. Waldron, M. A., *Assistant Botanist.*
L. Van Es, M. D., V. S., *Veterinarian.*
W. B. Richards, B. S. A., *Assistant Animal Husbandman.*
O. O. Churchill, B. S., *Assistant in Plant Breeding.*
Fred J. Pritchard, B. S., *Assistant Botanist, Plant Pathologist.*
Nicholas Grest, *Farm Foreman.*
C. E. Nugent, *Secretary.*
O. A. Thompson, *Superintendent of Edgeley Substation.*

#### GENERAL OUTLOOK.

There has been no material change during the past year in the policy or work of the North Dakota Station. The extensive field experiments have been continued, and have included cultural, fertilizer, and rotation experiments with many varieties of plants. Direct result from the station work with barnyard manure is rendered apparent by the fact that all the better farmers now care for and use barnyard manure, while only a few years ago few of them would give it any attention. The field work also includes a large number of breeding experiments, experiments in growing flax and other fiber plants, work with legumes, and pasture trials. In connection with the field work the chemist is studying variations in humus, and is making tests with sweet corn to secure varieties with higher sugar content adapted to canning. The botanist continues to study flax diseases, is spraying for Canada thistles and for wild mustard, and is studying smuts of small grains, rusts and other diseases of plants.

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[a] Freight and express address, *Fargo.*

There is considerable forestry work and much work with fruits to discover hardy varieties. Strawberries have done well and a raspberry (Colorado Ironclad) has been found that seems to be hardy and produces well.

The station continues to cooperate with the Bureau of Plant Industry of this Department in the investigation of cereals, forage plants, and other crops; the introduction of improved varieties of flax, and studies on the influence of origin of red clover seed on yield of crop; and with the Bureau of Soils in a soil survey.

The North Dakota Station is making good progress considering the limited funds at its disposal. There is need of money for additional work in animal husbandry and also for the erection of a horticultural building, greenhouses, and a seed barn. The college is disposed to be quite liberal with the station, but is itself cramped financially. The legislature last winter passed a bill appropriating for the station $10,000 in addition to the appropriation for the Edgeley Substation, but the governor vetoed the bill. The station is coming into close touch with the farmers and is doing a large amount of valuable work which they are applying in practice, and it should therefore have their active support in securing more liberal State appropriations. With the progress of the station it will undoubtedly be desirable to more clearly differentiate the experimental operations on the farm from those immediately connected with the courses of instruction in the college.

## LINES OF WORK.

The principal lines of work conducted at the North Dakota Station during the past year were as follows: Chemistry—investigation with soils and fertilizers, study of gluten content of selected wheats, and of plant food in soils; botany—studies of grasses and forage plants and noxious and poisonous weeds, seed control; field experiments—rotations, methods of culture, tests of hardy varieties of cereals and forage plants, selection of seed, selection and improvement of potatoes, sugar beets, corn, clover, alfalfa, and other farm crops; plant breeding—cereals; horticulture—variety tests of native plums and other fruits and of vegetables, experiments with forest trees; analysis of foods; diseases of plants—flax wilt, rusts, smuts, etc.; animal husbandry—feeding experiments with horses, mules, sheep, and pigs, and tests of the comparative feeding value of brome grass and timothy; diseases of animals; dairying; tests of farm machinery.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation for substation | 750.00 |
| Farm products | 4,549.90 |
| Miscellaneous | 181.00 |
| Total | 20,480.90 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 56–61 and the Annual Report for 1903. The subjects of the bulletins were noxious weeds and how to kill them; some food products and food adulterations; some stock-poisoning plants of North Dakota; trees and fruit in North Dakota; analyses of formaldehyde sold in North Dakota, and scabies in sheep and cattle, and mange in horses. The Annual Report, in addition to summary accounts of the work of the year in the different departments of the station, includes Bulletin 59.

## OHIO.

### Ohio Agricultural Experiment Station, *Wooster.*

### GOVERNING BOARD.

Board of Control: D. D. White (*President*), *Castalia;* O. E. Bradfute (*Secretary*), *Xenia;* D. L. Sampson (*Treasurer*), *Cincinnati;* T. C. Laylin, *Norwalk;* Alva Agee, *Wooster.*

### STATION STAFF.

C. E. Thorne, M. S. A., *Director.*
W. J. Green, *Vice-Director; Horticulturist.*
C. G. Williams, *Agriculturist.*
A. D. Selby, PH. D., *Botanist.*
J. W. Ames, B. S., *Chemist.*
L. H. Goddard, C. E., *Experimentalist.*
H. A. Gossard, M. S., *Entomologist.*
W. H. Kramer, *Bursar.*
C. W. Wald, B. S., *Assistant Horticulturist.*
F. H. Ballou, *Assistant Horticulturist.*
J. S. Houser, B. S., *Assistant Entomologist.*
F. A. Welton, B. S., *Assistant Chemist.*
J. M. Van Hook, A. M., *Assistant Plant Pathologist.*
William Holmes, *Farm Foreman.*
C. A. Patton, *Assistant Foreman; Meteorologist.*
Faye Blayney, *Mailing Clerk.*
Mary M. Lee, *Stenographer.*
Cary Welty, *Mechanician.*
F. W. Glass, *Printer.*
Edward Mohn, *Superintendent of Substation* (*Strongsville*).
Lewis Schultz, *Superintendent of Substation* (*Carpenter*).
H. M. Wachter, *Superintendent of Substation* (*Germantown*).

## GENERAL OUTLOOK.

The work of the Ohio Station for the past year has followed the same general lines as formerly, attention being given primarily to agronomic and horticultural work, with related investigations in botany, chemistry, and entomology. The experiments in fitting range steers for market have been completed. The work with live stock has been temporarily discontinued, but is to be taken up again as soon as funds for the purpose are available. It is realized that while general crops and cereals have been of leading importance in Ohio, the live-stock interests are large and steadily growing and should receive attention by the station.

The work of the Ohio Station in cooperation with this Department has included during the past year fiber investigations and studies of the influence of the origin of red-clover seed on the yield of crop with the Bureau of Plant Industry, and a soil survey with the Bureau of Soils. There is also a large amount of work in cooperation with farmers. This has recently been placed in charge of L. H. Goddard, who has been appointed experimentalist of the station and will also have charge of the test farm work. The entomologist resigned to return to the New York State Station, and has been succeeded by H. A. Gossard, late of the Florida University and Station. The southeastern test farm has been finally acquired. It is located at Carpenter, in the northern part of Meigs County, about 12 miles from the Ohio River. The farm contains 300 acres of land, and will be devoted to a study of the agricultural problems of the hill counties, special attention being given to the culture of pasture grasses and orchard fruits.

The Ohio Station now has its field and horticultural work organized in such a way as to conduct investigations simultaneously at Wooster and at three substations in widely separated parts of the State. It also has an effective organization for conducting experiments in cooperation with farmers. It is in a position to make good use of much larger funds to develop lines of work which are now given little attention. This is especially true with regard to investigations in animal husbandry.

## LINES OF WORK.

The principal lines of work conducted at the Ohio Station during the past year were as follows: Soils; field experiments—fertilizer and rotation experiments with corn, oats, wheat, potatoes, tobacco, and leguminous crops, variety tests of cereals, experiments with cover crops; horticulture—growing vegetables under cheese cloth, study of 175 varieties of plums, forcing tomatoes, lettuce, cucumbers, and muskmelons, variety tests of vegetables and fruits, orchard management; plant breeding and selection—corn and wheat; diseases of plants—Rhizoctonia in potatoes, onion smut, grape rot, diseases of ginseng and tobacco; breeding and feeding experiments with cattle; diseases of animals—bovine tuberculosis, stomach worms of sheep; and entomology.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation, including balance from previous year | 61,831.45 |
| Fees | 355.70 |
| Farm products, including balance from previous year | 7,354.04 |
| Miscellaneous | 6,375.48 |
| Total | 90,916.67 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 135, 136, 139, 141–149, 153, 155, and Annual Reports for 1901, 1902, and 1903. The subjects of the bulletins were as follows: Meteorological summary—press bulletins—index; the Hessian fly in Ohio; a rosette disease of potatoes; the maintenance of fertility; clover and alfalfa seeds; experiments with sulphur sprays for the fall treatment of the San José scale; studies in potato rosette; varieties of strawberries and raspberries; seed and soil treatment and spray calendar; peach diseases; the hardy catalpa as a farm crop; forcing tomatoes, and silage *v.* grain for dairy cows. There was also received Special Bulletin No. 1, pure-food law and rulings of the food commissioner.

## OKLAHOMA.

### Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College.

### GOVERNING BOARD.

Board of Regents: F. J. Wikoff (*President*), *Stillwater;* Governor T. B. Ferguson, *Guthrie;* H. G. Beard, *Shawnee;* T. J. Hartman (*Treasurer*), *Deer Creek;* H. C. R. Brodboll, *Ponca City;* W. H. Merten, *Guthrie.*

### STATION STAFF.

John Fields, B. S., *Director.*
L. L. Lewis, M. S., D. V. M., *Veterinarian.*
F. C. Burtis, M. S., *Agriculturist.*
O. M. Morris, B. S., *Horticulturist.*
W. R. Shaw, Ph. D., *Botanist, Entomologist.*
A. G. Ford, B. S., *Chemist.*
L. A. Moorhouse, B. S. A., *Assistant in Soils and Crops.*
J. F. Nicholson, M. S., *Assistant Bacteriologist.*
E. H. Riley, B. Agr., *Assistant Animal Husbandman.*
J. B. Griffing, B. S., *Assistant Agriculturist.*
M. J. Otey, *Clerk, Stenographer.*

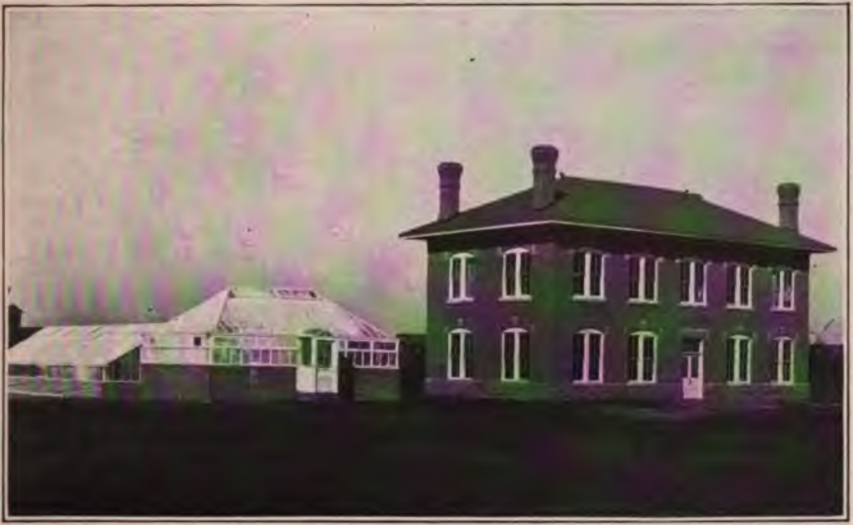

FIG. 1.—OKLAHOMA STATION GREENHOUSES AND DAIRY BUILDING.

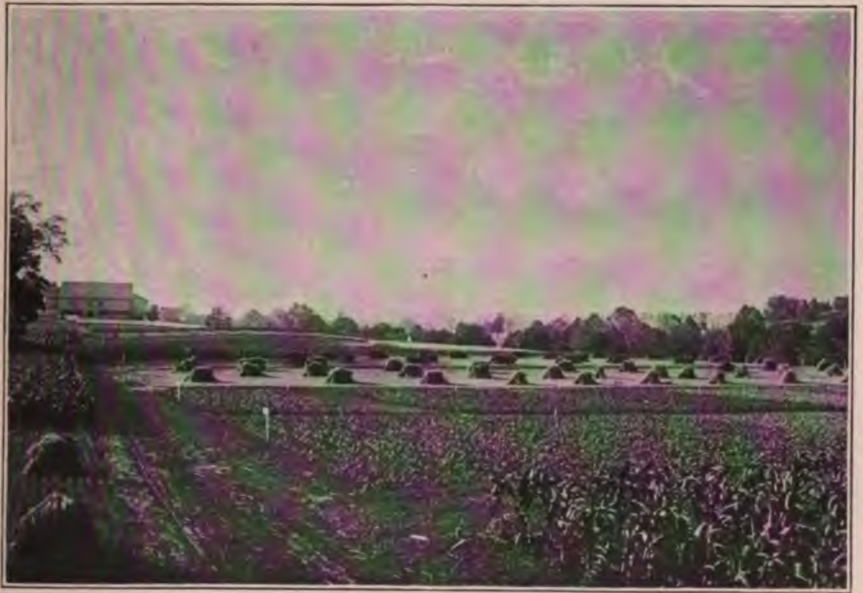

FIG. 2.—TENNESSEE STATION EXPERIMENTAL PLATS.

## GENERAL OUTLOOK.

During the past fiscal year the Oklahoma Station has been actively engaged in developing the lines of work which have been in progress for a number of years. As an important addition to the feeding experiments, the value of Kafir-corn meal is being tested as a grain feed in connection with prairie hay for horses. The experiments in feeding steers followed by hogs are being continued. The acquisition of more land for experimental purposes has enabled this station to give more attention to crop production, especially to experiments with corn, milo maize, Kafir corn, the smaller cereals, cotton, and forage crops. The improvement of Kafir corn by breeding and selection has been undertaken, and similar work with castor beans and cotton continued. The horticultural department is conducting a large number of variety tests with orchard and small fruits, and is studying the cultivation and pruning of grapes and grape stocks for grafting. Spraying experiments and tests of ornamental hedge plants, fruits, grasses, and other plants are other features of the horticultural work. The work in chemistry and veterinary science has been continued as heretofore, and a study of the bacteria of waters has been undertaken. The veterinary department distributed during the past year over 100,000 doses of blackleg vaccine among the Oklahoma stockmen. This work is supported by Territorial funds, and a part of the salaries of the veterinarian and his assistant are paid from the same funds.

A new dairy building, costing $4,000, and greenhouses, costing $3,000 (Pl. V, fig. 1), have been completed during the past year. There have been a number of changes in the station staff. Members of the staff take an active part in the farmers' institutes, one member attending, as a rule, an institute in each county in the Territory. There is a considerable demand for the services of station men as judges of live stock and agricultural products at county fairs, and so far as possible these requests are complied with. A moderate amount of work of this kind enables the station men to gain a better knowledge of the needs of the farmers, and also arouses considerable interest in the work of the station.

The efficient manner in which the Oklahoma Station is conducted and the value of the results attained are rapidly gaining recognition among the farmers and stockmen of the Territory. This fact is made apparent by the rapid growth of the station mailing list and the increasing demands upon it through correspondence and in other ways. These demands and the lack of adequate financial support have prevented the extension of investigations to numerous problems of equal importance to those now being studied. Some of the departments have better facilities in the way of buildings than formerly, but the station is still far from being properly housed. The offices and laboratories are scattered through a number of different buildings. There is urgent need of additional funds for laboratories, salaries, printing, and the extension of station investigations.

### LINES OF WORK.

The principal lines of work conducted at the Oklahoma Station during the past year were as follows: Chemistry; field experiments—cereals, pasture and forage crops, continuous cropping, rotation experiments, potatoes, improvement of Kafir corn, castor bean, and cotton; horticulture; forestry; diseases of plants; botany; animal husbandry—feeding experiments; diseases of animals—blackleg, parasites, dips, loco diseases; and entomology—Hessian fly, cotton-boll weevil, and melon louse.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Territorial appropriation | 1,421.78 |
| Farm products, including balance from previous year | 2,598.67 |
| Total | 19,020.45 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 58–63 and the Annual Report for 1903. The subjects of the bulletins are as follows: Fattening steers; planting trees for posts, fuel, and wind-breaks; field experiments; disinfecting power of coal-tar dips; and tuberculosis in hogs. Bulletin 59 contains reprints from Bulletins 47, 50, and 52, and Annual Reports 8–11. The reprinting of these bulletins was made necessary by the numerous requests for information contained in them.

## OREGON.

### Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College.

### GOVERNING BOARD.

Board of Regents: J. K. Weatherford (*President*), *Albany;* J. T. Apperson, *Parkplace;* John D. Daly (*Secretary*), *Portland;* B. F. Irvine (*Treasurer*), *Corvallis;* W. E. Yates, *Corvallis;* Governor George E. Chamberlain, *Salem;* F. I. Dunbar (*Secretary of State*), *Salem;* J. H. Ackerman (*State Superintendent* *of Public Instruction*), *Salem;* W. P. Keady, *Portland;* William W. Cotton,* *Worcester Building, Portland;* J. M. Church,* *Lagrande;* John D. Olwell,* *Centralpoint;* B. G. Leedy, *Tigardville.*

### STATION STAFF.

James Withycombe, M. Agr., *Director; Agriculturist.*
George Coote, *Florist, Gardener.*
A. B. Cordley, M. S., *Entomologist.*
E. R. Lake, M. S., *Forester, Botanist.*
A. L. Knisely, M. S., *Chemist.*
F. E. Edwards, B. M. E., *Assistant Chemist.*
C. M. McKellips, M. S., Ph. C., *Assistant Chemist.*
F. L. Kent, B. S. Agr., *Assistant Agriculturist, Dairyman.*
E. F. Pernot, M. S., *Bacteriologist.*
T. H. Crawford, M. A., *Clerk, Purchasing Agent.*
Helen L. Holgate, *Stenographer.*

### GENERAL OUTLOOK.

The work of the Oregon Station has been continued along the same lines as formerly. Some of the results of the experiments in feeding swine numerous products of the farm and orchard have been published, but the experiments have been continued as have also the soiling experiments with dairy cows. The investigations on steaming silage are yielding excellent results. The silage is steamed twice with a traction engine under pressure of about 30 pounds, and at a cost of about 40 cents per ton. This process arrests fermentation and gives an excellent feed in which the natural sugar of the plant is preserved. Another important piece of work is the canning of cheese. One of the recent developments in this investigation is the invention of a box in which eight Young America cheeses in hoops can be sealed up. The bacteriologist has also been working on canning vegetables under low temperatures, and perpetuating cream-ripening cultures in pasteurized skim milk.

Marked results have been obtained by the entomologist in spraying for apple scab, the increase in marketable fruit due to treatment being fully 17 per cent. The entomologist is also introducing the Chinese ladybird for the San José scale in cooperation with the Bureau of Entomology of this Department. The condition of the station farm has been greatly improved of late by the system of rotation practiced for a number of years. This consists of corn, wheat sown on the corn stubble, clover sown in the wheat in March and allowed to stay one to two years, then a cereal. This rotation requires only two plowings for a succession of at least four crops. Considerable work is being done with vetches grown in rotation and in combination with other crops, both for soiling purposes and for hay. An attempt is also being made to increase by selection the protein content of vetch, which is found to vary as much as 10 per cent in different plants.

The work of the station at Moro has been continued. At the East

Oregon Branch Station, which is conducted by the executive committee of the board, the work includes animal husbandry and the growing of sugar beets and sugar-beet seeds. Irrigation investigations in cooperation with this Office have been continued at Umatilla and elsewhere.

The work of the Oregon Station is in most respects very satisfactory and well adapted to the needs of the region. The horticultural work is not yet on a satisfactory basis, and there are some matters relating to the administration which have not been satisfactorily adjusted.

The increasing correspondence shows that the station is becoming better known among the farming people, and the great extension of clover growing in the State as a result of the station's rotation experiments shows that the farmers are looking to this institution for guidance. While the station is greatly cramped for funds, it is in better condition with reference to its work and the attitude of the people toward it than ever before in its history.

### LINES OF WORK.

The principal lines of work conducted at the Oregon Station during the past year were as follows: Chemistry—analytical work, investigations with silage, waste products for fertilizers, plant food in soils, physics of soils, experiments in drying hops, study of protein in vetch hay; bacteriology; soils; field crops—rotations, variety tests of cereals, grasses and other forage crops, hops, fertilizer tests, horticulture; diseases of plants; digestion and feeding experiments with dairy cows and swine, including soiling experiments with both; entomology; dairying, including investigations on the curing of cheese, and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 1,708.13 |
| Total | 16,708.13 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 76–80. Bulletin 77 is a continuation of Bulletin 74 on onions, and also contains notes on strawberries and vegetables. The other bulletins are on leguminous forage crops, canning cheese, plant food and use of fertilizers, and some results in swine feeding.

# PENNSYLVANIA.

## The Pennsylvania State College Agricultural Experiment Station, *State College*.[a]

Department of the Pennsylvania State College.

### GOVERNING BOARD.

Board of Trustees: J. A. Beaver* (*President*), *Bellefonte;* G. W. Atherton* (*Secretary ex officio*), *State College;* Frank M. Fuller (*Secretary of Commonwealth, ex officio*), *Uniontown;* N. B. Critchfield (*Secretary of State Board of Agriculture, ex officio*), *Harrisburg;* Governor S. W. Pennypacker (*ex officio*), *Harrisburg;* Hiram Young (*President of State Agricultural Society, ex officio*), *York;* I. B. Brown (*Secretary of Internal Affairs, ex officio*), *Harrisburg;* T. J. Stewart (*Adjutant-General, ex officio*), *Harrisburg;* N. C. Schaeffer (*Superintendent of Public Instruction, ex officio*), *Harrisburg;* John Birkinbine (*President of Franklin Institute, ex officio*), *Philadelphia;* Charles Miller, *Franklin;* Andrew Carnegie, *Pittsburg;* H. V. White,* *Bloomsburg;* C. W. Stone, *Warren;* Charles M. Schwab, *Pittsburg;* J. A. Woodward,* *Howard;* M. E. Conard, *Westgrove;* H. Walton Mitchell, *Pittsburg;* L. M. Colfelt, *Philadelphia;* Gabriel Hiester,* *Harrisburg;* Ellis L. Orvis, *Bellefonte;* W. F. Hill, *Montalto;* J. A. Herr, *Cedar Springs;* J. G. White, *New York City*.

### STATION STAFF.

H. P. Armsby, PH. D., LL. D., *Director*.
William Frear, PH. D., *Vice-Director; Chemist*.
W. A. Buckhout, M. S., D. Sc., *Botanist*.
G. C. Butz, M. S., *Horticulturist*.
G. C. Watson, B. AGR., M. S., *Agriculturist*.
W. C. Patterson, *Farm Superintendent*.
Julia C. Gray, *Secretary, Librarian*.
J. A. Fries,[b] B. S., *Assistant in Animal Nutrition*.
M. S. McDowell, M. S., *First Assistant Chemist*.
J. P. Pillsbury, *Assistant Horticulturist*.
M. H. Pingree, B. S., *Assistant Chemist*.
T. M. Carpenter, B. S., *Assistant Chemist*.
W. W. Braman, B. S., *Assistant in Animal Nutrition*.
R. E. Stallings, M. A., *Assistant in Animal Nutrition*.
N. G. Miller, B. S., *Assistant Agriculturist*.
N. C. Hamner, B. S., *Assistant Chemist*.
A. W. Clark, B. S., *Assistant Chemist*.
H. D. Edmiston, *Laboratory Assistant*.

### GENERAL OUTLOOK.

The work of the Pennsylvania Station during the past fiscal year has been of substantially the same character and along the same general lines as in previous years. The experiments to test the relative economy of feeding steers in pens and in stables gave results in favor of the stables. The experiments with soiling crops to provide green forage throughout the season have been successful and are being continued on a larger scale. The demonstrative spraying experiments for grape diseases in Erie County were quite successful and attracted considerable attention.

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[a] Freight.

[b] On leave.

The work with the respiration calorimeter in cooperation with the Bureau of Animal Industry of this Department continues to occupy a very prominent place in the investigations of the station. It is planned now to study the use of food in beef production, using two steers of different breeds and types and continuing the work over several years, during which time the steers will be fed in the respiration calorimeter for short periods at frequent intervals. The dairy wing of the new agricultural building of the college and station has been completed during the year, and is a fine building, well arranged and thoroughly up to date in every particular. While this building is intended primarily for instruction, it relieves the pressure for room in the station building.

The Pennsylvania Station is doing considerable good work, but it is much handicapped by the lack of funds. With its present resources it is impossible to expand the work in agronomy, horticulture, entomology, and diseases of plants, or to take up investigations in other lines much needed to promote the agricultural interests of the State. Considering the magnitude of these interests and the development of agricultural investigations in other regions, this station is not well supported relatively, and is not in a position to meet the reasonable demands made upon it by the farmers of the State.

### LINES OF WORK.

The principal lines of work conducted at the Pennsylvania Station during the past year were as follows: Chemistry—cooperation with other departments in the study of foods, feeding stuffs, excreta, fertilizers, and agricultural products, miscellaneous analytical work, experiments with tobacco, referee work for the Association of Official Agricultural Chemists of the United States; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture—variety tests of small fruits, experiments with crown gall of fruit trees, growing ginseng; field experiments—rotation experiments with fertilizers on 144 plants, rotation of legumes for soiling purposes, tobacco culture, variety tests of farm crops; feeding experiments—investigations in animal nutrition in the respiration calorimeter, feeding steers and correlated chemical studies on the relative losses from the manure of fattening cattle under different conditions of feeding; dairying—building up a herd from common stock, feeding dairy cows, study of the effect of keeping drinking water constantly before cows, effect of variety in the grain ration of cows, experiments to test the value of a home-mixed calf meal as a substitute for milk in rearing calves.

INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 1,000.00 |
| Fees | 15,420.60 |
| Farm products | 4,258.51 |
| Miscellaneous | 98.81 |
| Total | 35,777.92 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 63–66, on the following subjects: Losses in manure, methods of steer feeding, forage and soiling experiments, and spraying grapes for black rot in Erie County, Pa.

## PORTO RICO.

### Porto Rico Agricultural Experiment Station, *Mayaguez*.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

D. W. May, M. Agr., *Special Agent in Charge; Animal Husbandman.*
J. W. van Leenhoff, *Coffee Expert.*
O. W. Barrett, *Entomologist, Botanist.*
H. C. Henricksen, B. Agr., *Horticulturist.*
E. F. Curt, *Farm Superintendent.*

GENERAL OUTLOOK.

The work of the Porto Rico Station has been considerably enlarged during the past year, and many permanent improvements have been made on the station farm. A small tile machine was purchased and drain pipes were manufactured on the farm. Practically all the river-bottom or alluvial land on the station farm has been drained. This is the first underdrainage ever undertaken in Porto Rico, and it is believed that it will not only greatly enhance the producing power of the station property, but will also serve as a valuable object lesson to the planters of the island. An experimental irrigation system has also been installed on the farm, and some work in irrigation in cooperation with this Office has been taken up. The Bureau of Plant Industry of this Department has also aided the station greatly through its active cooperation.

The investigations on different methods of pruning, shading, and fertilizing coffee plants have been continued. An attempt to exterminate the coffee leaf miner by hand-picking the leaves proved the impracticability of this method of repressing this pest. The entomologist of the station has also been investigating the possibility of combating this insect by means of parasites, and reports the discovery of an effective parasite which, it is believed, by careful propagation and distribution, will aid very materially in keeping in check this insect, which is by far the most serious enemy to coffee cultivation now upon the island. A special study of the diseases of coffee and other plants was made by the botanist of the Connecticut State Experiment Station, who was temporarily in the employ of the Porto Rico Station. A preliminary survey of the principal tobacco districts of the island has been made by a tobacco specialist in the employ of the station, and a report on these investigations is being prepared.

Much attention is being given to the propagation of citrus fruits, especially with a view of obtaining better stock for growing in the orchards of Porto Rico. A bulletin on the methods of production and marketing of oranges, with special reference to Porto Rico conditions, has recently been issued. A large number of tropical fruits have been brought together in a tropical-fruit orchard. The tea, rubber, and cacao plantations are flourishing and are being extended. Among the tropical vegetables which enter into the variety tests are the yautia, taro, edible canna, arrowroot, cassava, yams, and sweet potatoes, all of which have thus far done well.

Experiments are being carried on with a number of fiber plants. Among these maguey and sisal have thus far given very promising results. The station has thus far conducted no careful experiments with cotton, but the industry has been extended throughout the island to a considerable extent during the past year, and the station officers report that the results seem to indicate that it is possible to profitably produce a medium grade of Sea Island cotton in Porto Rico. The special agent in charge of this station resigned during the year and has been succeeded by D. W. May, formerly of the Kentucky Station.

The Porto Rico Station has made good progress both in the preliminary work necessary to bring its farm and other equipment into shape for conducting experiments and in the inauguration of important investigations. In the latter work first consideration has been given to some of the more urgent problems confronting the planters in Porto Rico, and at the same time attention has been given to the introduction of new crops and new industries. The local interest taken in the work of the station, as indicated by an appropriation of $2,700 and by the demand for its publications, is very encouraging.

### LINES OF WORK.

The principal lines of work of the Porto Rico Station during the past year were as follows: Collection and variety tests of tropical vegetables and fruits; cultural and fertilizer tests with northern-grown crops to determine their adaptation, time of planting, etc.; experiments with fiber plants; investigations of injurious insects, and fungus and bacterial diseases of plants; selection of coffee; rejuvenation of an old coffee plantation; tobacco investigations; soil survey, and distribution of seeds for trial by farmers.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Insular appropriation | 2,700.00 |
| Farm products | 987.70 |
| Total | 18,687.70 |

### PUBLICATIONS.

The fifth report on investigations in Porto Rico, giving a detailed account of operations during the year 1904, has been prepared by the special agent in charge of the Porto Rico Experiment Station, and is given on page 383. The publications received from the station during the past fiscal year were Bulletin 3, on the soil survey from Arecibo to Ponce, P. R., and Circular 1, on Sansevieria.

## RHODE ISLAND.

### **Rhode Island Agricultural Experiment Station,** *Kingston.*

Department of Rhode Island College of Agriculture and Mechanic Arts.

### GOVERNING BOARD.

Board of Managers; Chas. Dean Kimball (*President*), *Providence;* Jesse V. B. Watson (*Vice-President*), *Wakefield;* C. H. Coggeshall (*Clerk*), *Bristol;* Melville Bull (*Treasurer*), *Newport;* T. G. Mathewson, *East Greenwich.*

### STATION STAFF.

H. J. Wheeler, PH. D., *Director; Chemist.*

F. W. Card, M. S., *Horticulturist.*

C. Curtice, D. V. S., M. D., *Biologist, Poultryman.*

B. L. Hartwell, PH. D., *Associate Chemist.*

J. W. Kellogg, B. S., *Assistant Chemist.*

G. E. Adams, B. S., *Assistant in Field Experiments.*

Matthew Steel, M. S., *Second Assistant Chemist.*

M. A. Blake, B. S., *Assistant Horticulturist.*

Nathaniel Helme, *Meteorologist.*

B. A. Hoitt, *Stenographer, Accountant.*

Martha Vickery, *Stenographer, Librarian.*

### GENERAL OUTLOOK.

The Rhode Island Station has continued the lines of investigations mentioned in the previous report of this Office and developed some new work, including two new rotation experiments, experiments in the propagation of the swamp blueberry, studies of the adaptability of alfalfa to Rhode Island conditions, and of the effect of sterilization on the productiveness of greenhouse soils, and some new poultry work. The addition of a new steam heating plant in the incubator and brooding house and other improvements to the poultry plant have made it possible to extend and improve the poultry investigations. Special attention is now being given to a study of the temperature and other conditions best suited to the rearing of winter brooder chicks. There have been a number of changes in the staff, including several promotions, resignations, and appointments in the department of chemistry. B. L. Hartwell, formerly first assistant chemist, has been made associate chemist. The extension work of the college supported by State funds has been continued and will be extended to include the services of the lecturers at meetings of farmers. The inspection of fertilizers and feeding stuffs has been continued at State expense.

The Rhode Island Station has in hand considerable work of a scientific character, but is unable from lack of funds to maintain all that might be desired in the way of a chemical control of field experiments or to develop any considerable amount of new work, however great may be the demand for such development.

### LINES OF WORK.

The principal lines of work conducted at the Rhode Island Station during the past year were as follows: Chemistry—analytical work in connection with other experimental investigations; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments—fertilizers, rotations *v.* continuous cropping, variety tests, experiments with grasses, comparative tests of insecticides and fungicides; horticulture—rejuvenation of old orchards, manurial experiments with bush fruits, selection and breeding of fruits (raspberries and blackberries), and vegetables, orchard cover crops, artificial propagation of blackberries, study of forest conditions, combating insect pests, experiments in grafting; and poultry experiments—diseases, brooding, incubation, etc.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 534.53 |
| Miscellaneous, including balance from previous year | 2,256.47 |
| Total | 17,791.00 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 93–99 and the Annual Report for 1903. Two of the bulletins are concerned with commercial fertilizers and two with feeding stuffs. The remaining subjects are cooperative experiments in top-dressing grass land, a six-year rotation of crops, and a further study of the influence of lime upon plant growth. The Annual Report includes the following special articles: Blooming period of fruits, clover, color of flowers, corn selection, gasoline as a remedy against enemies of the squash, huckleberries, ilex, spraying peach foliage, strawberry seedlings, durability of posts, the function of sodium and nitrate of soda, and a summary of meteorological observations during the year.

## SOUTH CAROLINA.

### **South Carolina Agricultural Experiment Station,** *Clemson College.*[a]

Department of Clemson Agricultural College.

#### GOVERNING BOARD.

Board of Trustees: R. W. Simpson (*President*), *Pendleton;* P. H. E. Sloan (*Secretary and Treasurer*), *Clemson College;* D. K. Norris, *Cateechee;* M. L. Donaldson,* *Greenville;* R. E. Bowen, *Briggs;* B. R. Tillman,* *Trenton;* J. E. Bradley, *Troy;* W. D. Evans, *Cheraw;* L. A. Sease, *Prosperity;* J. E. Wannamaker,* *St. Matthews;* A. T. Smythe,* *Charleston;* G. Duncan Bellinger, *Columbia;* J. E. Tindal,* *Felder;* J. H. Hardin, *Chester;* H. M. Stackhouse (*Secretary of Fertilizer Department*), *Clemson College.*

#### STATION STAFF.

P. H. Mell, M. E., Ph. D., LL. D., *Director.*
J. S. Newman, *Vice-Director; Agriculturist.*
M. B. Hardin, *Chief Chemist.*
H. Metcalf, M. A., Ph. D., *Botanist, Bacteriologist.*
B. F. Robertson, B. S., *Assistant Chemist.*
F. S. Shiver, Ph. G., *Assistant Chemist.*
H. Benton, M. S., *Assistant Agriculturist.*
R. N. Brackett, Ph. D., *Assistant Chemist.*
C. C. McDonnell, B. S., *Assistant Chemist.*
D. H. Henry, B. S., *Assistant Chemist.*
F. C. Atkinson, M. S., *Assistant Chemist.*
C. C. Newman, *Horticulturist.*
C. E. Chambliss, M. S., *Entomologist.*
L. A. Klein, V. M. D., *Veterinarian.*
B. H. Rawl, B. S., *Animal Husbandman.*
J. S. Pickett, *Station Foreman.*
J. N. Hook, *Secretary.*

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[a] Telegraph office, *Clemson College;* express and freight address, *Calhoun.*

### GENERAL OUTLOOK.

The South Carolina Station has continued the lines of work noted in the last report of this Office and has developed considerable new work, especially in the coast region of the State. In the experiments with forage plants sorghum is proving one of the most valuable. The Newman bean, which has been grown as a soil renovator for a number of years, is now being investigated as a forage plant.

Experiments are being carried on with soil and pure cultures for the inoculation of corn, clover, hairy vetch, cowpeas, alfalfa, and other leguminous plants. Cultural and fertilizer tests with varieties of wheat and oats have been begun. An attempt is being made to domesticate and develop the common maypop into a valuable edible fruit. Already by cultivation and selection the size of some of the fruits has been increased by 50 per cent, and a number of forms have been secured that are believed worthy of further trial. Another important line of work recently taken up is that of rice culture. Studies are being made of the rice soils, fertilizers, methods of cultivation, diseases, and insects, the work being done through the cooperation of several departments of the station, as well as in cooperation with the Bureau of Plant Industry and the Bureau of Entomology of this Department. The department of botany at the station has been giving its entire time to the study of the blast or blight disease of rice, which threatens to devastate the Carolina rice fields. The botanist reports the probable determination of the cause of the disease, and believes that he has the key to its control by perfectly practical methods. Feeding experiments with cattle and breeding experiments with cattle and sheep have been inaugurated, and the parasites of these animals are being studied. Experiments on the use of spraying as a substitute for dipping cattle to remove ticks are being carried on.

The horticulturist has experimented with potatoes, celery, cantaloupes, and other truck crops, largely in cooperation with the Bureau of Plant Industry of this Department, and an attempt is also being made to grow truffle oaks. Cooperation with the Bureau of Plant Industry also includes work on two diversification farms, experiments with corn, spraying cucumbers and melons to prevent diseases, and the rice investigations mentioned above.

A substation has been started at Charleston, which is conducted under the auspices of the station, the agricultural committee of the State Agricultural Society, and the Bureau of Plant Industry of this Department, and under the immediate supervision of W. D. Garrison. At this place experiments are being made with Egyptian corn, teosinte, beggar weed, and other forage crops, broom corn, flax, tobacco, oats, wheat, barley, and some other crops. The effort is being made to determine which of these crops can be profitably used to diversify agricultural operations in the coast region of the State. Farmers' institutes, under the direction of station officers, have been continued. The vice-director has tendered his resignation, to take effect at the end of the present fiscal year. The veterinarian has resigned to accept a position as assistant chief of the Bureau of Agriculture in the Philippines, and has been succeeded by Dr. Louis A. Klein, who was at one time on the staff of the Iowa State College. The new agricultural building has been completed, and affords much better facilities for the different divisions of the agricultural department, including also those of the station. Plans have been made for a new range of greenhouses, to cost $5,000, and for the improvement of the grounds under the direction of a landscape architect.

The reorganization of the South Carolina Station begun last year has been continued, and the college and station farms and herds are now wholly separated and are under the charge of different foremen. Improvements of great importance have been completed during the year, and others are contemplated which will greatly enlarge the facilities for investigations. The officers of the station have shown great activity in attacking the problems which concern the Carolina farmer in all parts of the State, and are making an earnest effort to develop the latent possibilities in sections where the one-crop system

### LINES OF WORK.

The principal lines of work conducted at the South Carolina Station during the past year were as follows: Chemistry—study of different forage plants, plant food in soils; analysis and control of fertilizers; botany—diseases of rice; field experiments—domestication of native grasses and other forage crops, tests of crops for economic pork production, rotations, tests of sorghum and Kafir corn for hay, experiments with varieties of wheat and oats; horticulture; plant breeding—cotton, strawberries; feeding experiments—mainly with dairy cows and poultry; veterinary science—diseases of poultry, inoculation for Texas fever; entomology—orchard inspection, methods of destroying insect pests of fruits and vegetables; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 3,815.10 |
| Total | 18,815.10 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 81-87 and the Annual Report for 1903. The subjects treated in the bulletins include practical experiments with the peach borer, the one-horse farm, commercial fertilizers, tobacco culture in South Carolina, and artificial incubation of chickens.

## SOUTH DAKOTA.

### South Dakota Agricultural Experiment Station, *Brookings.*

Department of South Dakota Agricultural College.

### GOVERNING BOARD.

State Board of Regents of Education: I. W. Goodner (*President*), *Pierre;* F. A. Spafford, *Flandreau;* I. D. Aldrich (*Secretary*), *Bigstone;* M. F. Greeley,* *Gary;* A. W. Burtt, *Huron;* R. M. Slocum,* *Herreid;* R. A. Larson (*Secretary and Accountant*), *Brookings.*

### STATION STAFF.

J. W. Wilson, M. S. A., *Director; Animal Husbandman.*

E. C. Chilcott, M. S., *Vice-Director; Agriculturist.*

J. H. Shepard, B. S., *Chemist.*

W. A. Wheeler, M. S., *Botanist, Entomologist.*

E. L. Moore, B. S., D. V. S., *Veterinarian.*

N. E. Hansen, M. S., *Horticulturist.*

A. B. Holm, B. S., *Assistant in Soils.*

A. H. Wheaton, *Assistant in Dairying.*

A. E. Koch, PH. G., *Assistant in Chemistry.*

F. A. Norton, PH. G., *Assistant Chemist.*

R. F. Kerr M. A., *Librarian, Statistician.*

R. A. Larson, *Accountant, Secretary.*

Sylvester Balz, *Superintendent of Highmore Substation.*

H. G. Skinner, B. S. A., *Assistant Animal Husbandman.*

William West, *Farm Foreman.*

Adolph Morlock, *Gardener, Florist.*

T. B. Kelly, *Stenographer.*

### GENERAL OUTLOOK.

The South Dakota Station is conducting extensive breeding experiments to secure fruits, cereals, forage crops, and live stock adapted to the climatic conditions of the State. The horticulturist is conducting numerous breeding and grafting experiments with a large number of hardy native and introduced fruits, among which may be mentioned the sand cherry, buffalo berry, peaches, apricots, apples, strawberries, gooseberries, and black currants. Thousands of seedlings are started, which are budded or grafted, and as soon as they come into bearing are subjected to a rigid selection and all of the undesirable individuals destroyed. In this way a number of excellent varieties have been originated. In much the same way cereals and native forage plants are being bred and selected at the station, the tests being supplemented at the Highmore Substation. The work with cereals is conducted in cooperation with the Bureau of Plant

Industry of this Department, which is also cooperating with the station on variety tests of vegetables and fiber investigations. Prominent among the cereal investigations are tests of macaroni wheats in comparison with bread wheats, and in this work the chemist is assisting. The latter has graded and milled the different varieties, determining the percentage of bran, shorts, and flour for each. The separate products are then analyzed to determine the crude protein, and the flours are subjected to further tests, including the color test, the wet and dry gluten test, the sponge test, and the bakers' test. The wheats have also been reduced to semolina, from which macaroni has been made. The process of elimination is practiced with the cereals as rigidly as with the fruits.

The breeding experiments with live stock are of more recent origin. These include, among other experiments, the breeding of Shorthorn, Hereford, and Aberdeen Angus bulls to common dairy cows for the purpose of comparing the progeny as to feeding qualities under South Dakota conditions. In this connection a comparison of the feeding value of different grains will be made. Breeding experiments with swine have also been started, the purpose being to secure the prolificness of the Yorkshires and the fattening qualities of the Poland Chinas by crossing. Feeding experiments with tankage, oil meal, and other concentrates have recently been inaugurated to determine the economy of using such feeds in finishing hogs for market. There are also some feeding experiments with sheep and steers and experiments on the formaldehyde vapor treatment of grain for the prevention of smut. The latter experiments have been quite successful and give promise of superseding the wet treatment for smut.

The new barn built during the past year with a State appropriation of $12,000 contains, in addition to the stables and storage lofts, a large class room for agronomy and farm machinery and a large room for stock judging. While intended primarily for the college, it will also furnish additional facilities for the station, especially in connection with the feeding experiments with cattle. The botanist and entomologist, who was absent on leave last year, has severed his connection with the station and has been succeeded by W. A. Wheeler.

The South Dakota Station is making steady progress in its work and is doing much to solve the problems of the farmers in that region. Its efforts to produce strains of farm crops and live stock adapted to the rigors of a northwestern winter and to the other climatic conditions of the State are of great importance, and are being pursued along scientific lines. Many of these investigations require a long time for completion, but they are fundamental, and the establishment of one new variety of fruit or grain or forage crop fully adapted to the region will more than offset the expense of the station to the Commonwealth.

### LINES OF WORK.

The principal lines of work conducted at the South Dakota Station during the past year were as follows: Physics and chemistry of soils; field experiments—rotations; plant breeding—selection and adaptation, including native and introduced fruits, cereals, and forage crops; diseases of plants and animals; animal husbandry—feeding and breeding experiments; entomology; and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15, 000. 00 |
| State appropriation | 1, 500. 00 |
| Miscellaneous | 1, 736. 12 |
| Total | 18, 236. 12 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications received from this station during the past fiscal year were Bulletins 79–82 and the Annual Reports for 1902 and 1903. The following are the subjects of the bulletins: Crop rotation for South Dakota; lamb feeding; macaroni wheat, its milling and chemical characteristics; pasture and forage plants, feeding dairy cows, flies, the artesian waters of South Dakota, some destructive insects, and elements of prairie horticulture. The Annual Reports contain financial statements and brief accounts of the work in the different departments of the station.

## TENNESSEE.

### **Tennessee Agricultural Experiment Station,** *Knoxville.*

Department of the University of Tennessee.

### GOVERNING BOARD.

Board of Trustees: Brown Ayres (*President*), *Knoxville;* James Maynard, (*Treasurer*), *Knoxville;* William Rule (*Secretary*), *Knoxville;* the Governor; Secretary of State; Superintendent of Public Instruction; H. G. Kyle, *Rogersville;* J. M. Boyd, *Knoxville;* J. W. Caldwell,* *Knoxville;* Chalmers Deaderick, *Knoxville;* S. B. Luttrell, *Knoxville;* Samuel McKinney, *Knoxville;* Hu L. McClung, *Knoxville;* James Park, *Knoxville;* E. T. Sanford, *Knoxville;* F. A. R. Scott, *Knoxville;* O. P. Temple,* *Knoxville;* Moses White, *Knoxville;* Xenophon Wheeler, *Chattanooga;* J. B. Frazier, *Nashville;* Harris Brown,* *Gallatin;* T. R. Myers, *Shelbyville;* J. B. Killebrew,* *Nashville;* T. F. P. Allison,* *Nash-*

*ville;* Z. W. Ewing, *Pulaski;* S. F. Thomas, *Brownsville;* T. E. Harwood,* *Trenton;* M. B. Trezevant, *Memphis;* J. M. Greer, *Memphis;* W. B. Lockett, *Knoxville;* W. W. Ogilvie, *Nashville;* James D. Porter, *Nashville;* W. C. Tatom, *Nashville;* John L. Rhea, *Knoxville.*

### STATION STAFF.

H. A. Morgan, B. S. A., *Director; Agriculturist.*
C. A. Keffer, M. S. A., *Horticulturist, Forester.*
C. A. Mooers, B. S., *Chemist.*
S. M. Bain, A. B., *Botanist.*
L. A. Judkins, *Meteorologist.*
F. H. Broome, *Librarian.*
S. E. Barnes, M. S. A., *Dairyman.*
W. H. Brown, B. S., *Assistant Chemist.*
M. Jacob, V. M. D., *Veterinarian.*
Ethel Reese, *Stenographer.*

### GENERAL OUTLOOK.

During the past year the Tennessee Station has closed studies on training and pruning fruit trees, increasing the yield of corn, replacing grain with alfalfa in a ration for dairy cows, and crops for the silo. Important results have also been secured from experiments in feeding beef and dairy cattle and swine; rotation experiments; improvement of cereals, especially wheat and corn; and tests of cereals and forage plants to ascertain their value for hay, grain, fodder or silage. The work with cereals and forage plants (Pl. V, fig. 2) is conducted largely in cooperation with the Bureau of Plant Industry of this Department. The botanist of the station is giving half of his time to the management of the experiments with cotton which the Bureau of Plant Industry is conducting in Tennessee and Arkansas. The chemist has charge of the fertilizer inspection which has recently been turned over to the station and has made some study of the fertilizer requirements of typical Tennessee soils. The horticulturist is giving special attention to fertilizer experiments on strawberries, tomatoes, melons, and other truck crops. Farmers' institutes were held during the year in nearly every county in the State, and at the close of the year the East Tennessee Farmers' Convention was in session for three days at the university.

The work of this station has been greatly retarded by the resignation of a number of the officers of the station, including the director, assistant agriculturist, and plat expert, who have accepted similar positions at the Virginia Station, and the meteorologist, who has gone into private business. The president of the university has also been changed during the year. In spite of these important changes and the consequent crippled condition of the station, an earnest effort is being made to continue most of the important lines of work carried on in previous years until a reorganization can be effected.

### LINES OF WORK.

The principal lines of work conducted at the Tennessee Station during the past year were as follows: Chemistry—pot and other experiments with soils, digestion experiments, analytical work; inspection of fertilizers; field experiments—selection of cereals and legumes, experiments with forage crops for soiling and silage, methods of cultivation, green manuring, tests of meadow grasses, grazing experiments, etc.; horticulture—cultural, fertilizer, and grafting experiments with orchard and small fruits and vegetables; seeds; weeds; diseases of plants; feeding experiments—beef and dairy cattle and hogs; entomology; and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Fees | 520.00 |
| Farm products | 4,999.78 |
| Miscellaneous | 4.18 |
| Total | 20,523.96 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins Vol. XVI, Nos. 1-4, Vol. XVII, Nos. 1 and 2, and the Annual Report for 1903. The subjects of the bulletins were fertilizer experiments; San José scale; corn, wheat, and soy-bean meal with skim milk for pork production; influence of climate and soil on the composition and milling qualities of winter wheat; crops for the silo, and increasing the yield of corn.

## TEXAS.

### **Texas Agricultural Experiment Station,** *College Station.*

Department of the State Agricultural and Mechanical College of Texas.

### GOVERNING BOARD.

Board of Directors: M. Sansom (*President*), *Fort Worth;* F. A. Reichardt, *Houston;* George T. Jester, *Corsicana;* W. J. Clay, *Austin;* A. J. Brown, *Dallas;* K. K. Legett, *Abilene;* A. Haidusek, *La Grange;* L. D. Amsler, Hempstead.

### STATION STAFF.

John A. Craig, B. S. A., *Director.*
H. H. Harrington, M. S., *Chemist.*
M. Francis, D. V. M., *Veterinarian.*
E. J. Kyle, M. S. A., *Horticulturist.*
E. C. Green, B. S., *Assistant Horticulturist.*
F. S. Johnston, B. S., *Agriculturist.*
O. M. Ball, Ph. D., *Botanist; Mycologist.*
G. S. Fraps, Ph. D., *Assistant Chemist.*
F. R. Marshall, B. S., *Animal Husbandman; Dairyman.*
R. L. Bennett, M. S., *Cotton Specialist.*
J. K. Robertson, *Superintendent of State Station* (*Beeville*).
W. S. Hotchkiss, *Superintendent of State Station* (*Troupe*).

### GENERAL OUTLOOK.

The past year has to a large extent been one of reorganization under the new director. As a result there has been a more or less unsettled condition with reference to station work, although the more important lines have in the main been continued, and in some cases developed. These include, as heretofore, field experiments in horticulture and general agriculture, investigations with reference to animal diseases and their prevention, feeding experiments with cattle and swine, and experiments at the substations—mainly with fruits, vegetables, and forage plants. In addition to the work with cattle noted in the last report of this Office there have been feeding experiments with swine, to compare green feeds alone with green feeds and concentrates, and in feeding swine the by-products of the dairy. Feeding experiments with sheep and possibly with horses are to be undertaken. The work in this department has been greatly facilitated by the willingness of stock raisers to loan animals to the station for the purposes of experiment. The station continues to give much attention to the study of the nature, cause, spread, and prevention of different animal diseases common in Texas, including especially Texas fever and blind staggers.

The work with field crops, vegetables, and fruits includes variety tests, experiments with fertilizers, and methods of culture to conserve moisture and improve tilth. Much of this work is done at the Beeville and Troupe substations, the former giving more attention to vegetable growing with supplemental irrigation, and the latter to fruit growing. These substations are supported by State funds and are now in charge of efficient local superintendents. Their work has been so popular that there is a strong demand for the establishment of other substations, and the director is disposed to favor at least one more (for feeding experiments, near Fort Worth), provided liberal appropriations are made for its equipment and maintenance.

The cooperative investigations of the station are now extensive and include cooperation with farmers in growing vegetables, especially potatoes, and with this Department as follows: A soil survey with the Bureau of Soils; investigation of insects injurious to cotton, exclusive of the Mexican cotton-boll weevil and the bollworm, in cooperation with the Bureau of Entomology, and experiments with cereals and truck crops, conducting 16 diversification farms, breeding cotton, and the extension of cotton culture in Texas in cooperation with the Bureau of Plant Industry. The extensive work with cotton is in charge of R. L. Bennett, formerly director of farmers' institutes. The latter are well supported and are now in charge of J. W. Carson, formerly farm superintendent. The consulting entomologist resigned during the year to accept a position in the New Hampshire College and Station.

A notable improvement during the year in the plan of operations at the Texas Station has been the grouping of the field experiments in general agriculture and the work with live stock on a portion of the farm which it is proposed to devote permanently to these purposes. Here permanent plats have been laid out and the special cotton experiments established. It is hoped in time to put up a barn and such other buildings as are needed for experimental work. The work in horticulture and with dairy cows and swine will be continued for the present on the old part of the farm. The farm buildings and their surroundings have been rearranged and improved, and a dairy barn has been completed at a cost of about $8,000. A notable development in all of the field work at the station is the increased attention given to fertilizers in response to a rapid growth of the use of fertilizers in the State. The station is better organized now for efficient work than it has been for some time, and in view of the greatly increased demands made upon it to extend its work along different lines it could profitably use much larger funds than it has at its command.

### LINES OF WORK.

The principal lines of work conducted at the Texas Station during the past year were as follows: Chemistry—nitrification, study of feeding stuffs; soils; field experiments—forage crops, variety tests, fertilizer and cultural experiments with corn and cotton; horticulture—variety, cultural, and fertilizer experiments with truck crops and fruits; feeding experiments; diseases of animals, and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15, 000. 00 |
| State appropriation for substations | 5, 000. 00 |
| Farm products | 200. 02 |
| Miscellaneous | 596. 00 |
| Total | 20, 796. 02 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 67–71 and the Annual Report for 1902. The subjects treated in the bulletins are commercial fertilizers and commercial poisonous insecticides, the manufacture of cane sirup, cabbage, the composition of Texas cotton-seed meal, and Irish potatoes at Troupe.

# UTAH.

## **Agricultural Experiment Station,** *Logan.*

Department of the Agricultural College of Utah.

### GOVERNING BOARD.

Board of Trustees: W. S. McCornick (*President*), *Salt Lake City;* J. A. Bexell (*Secretary*), *Logan;* F. D. Farrell (*Assistant Secretary*), *Logan;* Allan M. Fleming (*Treasurer*), *Logan;* Mrs. Emily S. Richards, *Salt Lake City;* John A. McAlister, *Logan;* L. Hansen,* *Logan;* Mrs. R. N. Bagley, *Ogden;* Geo. C. Whitmore,* *Nephi;* E. R. Owen,* *Wellsville.*

### STATION STAFF.

John A. Widtsoe, Ph. D., *Director; Chemist.*
Lewis A. Merrill, B. S., *Agronomist.*
R. S. Northrop, B. S., *Horticulturist.*
E. D. Ball, M. S., *Biologist.*
R. W. Clark, B. Agr., *Animal Industry.*
W. W. McLaughlin, B. S., *Irrigation Engineer.*
P. A. Yoder, Ph. D., *Associate Chemist.*
John A. Crockett, *Assistant Dairyman.*
Robert Stewart, B. S., *Assistant Chemist.*
Wm. Jardine, B. S. A., *Assistant Agronomist.*
J. E. Greaves, B. S., *Assistant Chemist.*
J. B. Nelson, *Farm Foreman.*
John Hopkins, *Foreman of Poultry Department.*
Henry W. Crockett, *Foreman of Horticultural Grounds.*
Wm. Hodges, *Foreman of Animal Industry.*

### GENERAL OUTLOOK.

The investigations of the Utah Station are concerned mainly with the correct use of water for different crops. Closely allied with the irrigation investigations are those for the reclamation of alkali soils and the work in dry farming The arid farms provided for by the State legislature have been in operation one year, with most gratifying results. It seems at the present time as if it will be possible by the use of rational methods of culture to grow crops profitably on millions of acres of land in Utah which has always been looked upon as hopelessly barren. One important piece of work in this connection is the development by the station of winter varieties of macaroni wheat suitable to dry farming. The alkali reclamation work is conducted in cooperation with the Bureau of Soils of this Department, and the irrigation investigations in cooperation with this Office. The station is also cooperating with the Bureau of Plant Industry in sugar-beet investigations and experiments with various truck crops, and with the Bureau of Chemistry on the effect of environment on the chemical composition of sugar beets.

In the department of animal husbandry attention has been given mainly to the best use of alfalfa and sugar-factory by-products in the development of the dairy and swine industries. The poultry department is emphasizing its breeding experiments, leading, it is hoped, to the establishment of poultry strains with high egg-laying qualities. This department is also giving considerable attention to the question of artificial incubation. The high elevation of this district, with its dry climate, introduces difficulties in artificial incubation unknown to eastern breeders. The work in horticulture has suffered greatly during the past few years from the frequent changes in the management of that department. However, this work has been so systematized now that the recent change will not seriously interrupt the work. The entomological work of the past year has been concerned mainly with investigations on the codling moth and grasshoppers.

Farmers' institute work has been continued under the control of the director, the station men participating in it to a considerable extent. This work is now better systematized than formerly and is better appreciated by the people of the State. During the past year the poultry plant has been greatly improved by the erection of a new poultry building costing $3,500 (Pl. VI, fig. 1). The station has also erected a new piggery and installed an experimental mill for testing the milling qualities of grains grown under different systems of irrigation. For the purpose of extending the irrigation studies another small farm of about 4 acres has been completely equipped with weirs, flumes, and other devices necessary to control the amount of water applied. A centrifugal soil elutriator has been devised and constructed at the station which possesses a number of advantages over older forms of this apparatus. The horticulturist of the station has resigned recently to accept a similar position at the Maryland College and Station, and has been succeeded by R. S. Northrop, of the Cornell Station.

The systematizing of the station investigations at Logan and the better facilities afforded by new buildings, additional land for investigations, and State appropriations for publications and special investigations have enabled the Utah Station to make very substantial progress. That it is better appreciated by the people and is meeting their approval is shown by increased correspondence, more frequent requests for bulletins, more numerous notices in the newspapers of the State, and the greater willingness of the State legislature to provide for its needs. A movement is now on foot to bring the southern Utah experiment farm under the direction of this station, which will be an advantage in better systematizing and controlling the different agricultural investigations throughout the State. The station is still in need of additional funds to enable it to keep pace with the rapid progress of agriculture in the State, and there is good prospect that with the present appreciative attitude of the people these funds will be provided in the near future.

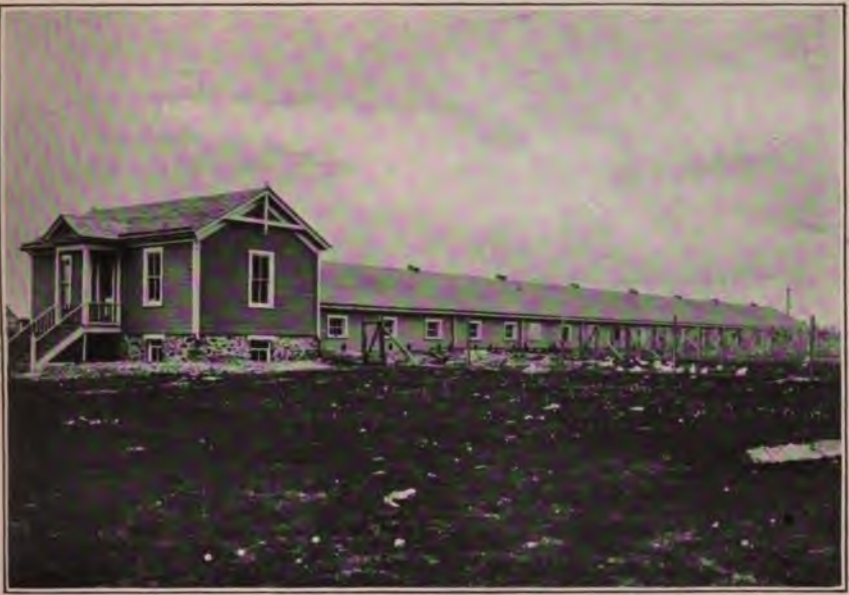

FIG. 1.—NEW POULTRY HOUSE AT UTAH STATION.

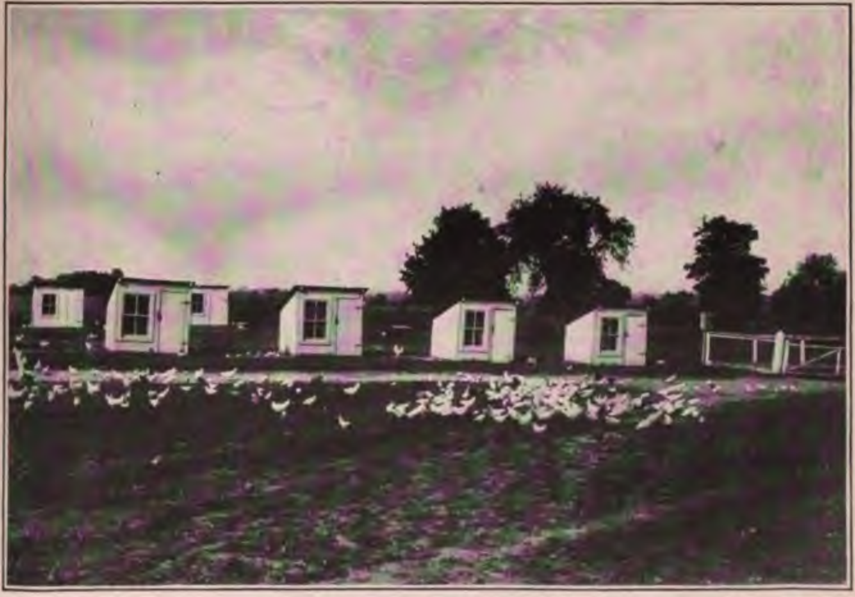

FIG. 2.—COLONY HOUSES USED IN POULTRY EXPERIMENTS AT WEST VIRGINIA STATION.

### LINES OF WORK.

The principal lines of work conducted at the Utah Station during the past year were as follows: Chemistry—soils, feeding stuffs; alkali soil investigations—reclamation of alkali soils; meteorology; field experiments—rotations, testing varieties of cereals, sugar beets, and garden vegetables, arid farming; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments—cattle, sheep, horses; dairying; poultry experiments; entomology; irrigation—seepage investigations, water requirements of plants and soils.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products, including balance from previous year | 488.59 |
| Total | 15,488.59 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 78–87 and the Annual Report for 1902, the latter containing a list of all the bulletins issued by the station since its organization. The subjects of the bulletins are as follows: Experiments in fattening lambs, process butter—a dairy fraud, irrigation investigations in 1901, poison in water from a gold and silver mill, feeding beet pulp to steers and sheep, pruning of tree and bush fruits, the grain smuts, pear blight, the right way to irrigate, and the codling moth.

## VERMONT.

**Vermont Agricultural Experiment Station,** *Burlington.*

Department of University of Vermont and State Agricultural College.

### GOVERNING BOARD.

Board of Trustees: M. H. Buckham * (*President*), *Burlington;* Governor J. G. McCullough (*ex officio*), *Bennington;* G. G. Benedict (*Secretary*), *Burlington;* E. H. Powell (*Treasurer*), *166 College street, Burlington;* H. H. Powers, *Morrisville;* J. H. Converse, *Philadelphia, Pa.;* Elias Lyman, *Burlington;* Robert Roberts, *Burlington;* W. S. Webb, *Shelburne;* D. P. Kingsley, *New York City;* B. F. Fifield, *Montpelier;* N. W. Fisk, *Isle La Motte;* Redfield Proctor, *Proctor;* E. J. Ormsbee,* *Brandon;* W. P. Dillingham, *Montpelier;* G. T. Chaffee, *Rutland;* H. C. Cleveland, *Coventry;* G. S. Fassett,* *Enosburg;* Cassius Peck,* *Burlington;* C. A. Catlin, *Providence, R. I.*

### STATION STAFF.

J. L. Hills, D. Sc., *Director.*
G. H. Perkins, Ph. D., *Entomologist.*
L. R. Jones, Ph. B., *Botanist.*
William Stuart, M. S., *Horticulturist.*
F. A. Rich, V. S., M. D., *Veterinarian.*
Cassius Peck, *Farm Superintendent.*
C. H. Jones, B. S., *Chemist.*
W. J. Morse, M. S., *Assistant Botanist.*
F. M. Hollister, B. S., *Assistant Chemist.*
C. L. Stygles, *Dairyman.*
Mary A. Benson, *Stenographer.*
E. H. Powell, *Treasurer.*

### GENERAL OUTLOOK.

During the past fiscal year the Vermont Station has completed a notable investigation on the flow of maple sap, which has covered several seasons, and is the most comprehensive investigation of its kind which has been made. This work has been reported in both a technical bulletin and a popular bulletin. The station has also perfected a simple test for the adulteration of maple sugar with cane sugar, and will continue some other investigations along this line. Varieties of potatoes are being tested for resistance to scab on soils which are infected, and Mexican potatoes are being crossed with the Irish potato to secure resistance to blight and to the potato bug: the latter will not trouble the Mexican potato. The work of the botanist is also largely with potatoes in testing different methods of controlling the blight and the rot. He is also working on the soft rots of a number of vegetables in cooperation with the New York State Station. Cooperation with the Bureau of Plant Industry of this Department on drug plants and on grass and forage plants and seeds offered for sale in Vermont has been continued, and investigations with truck crops and on the influence of origin of red-clover seed on the yield of crop have been taken up. A soil survey in cooperation with the Bureau of Soils has also been started.

Members of the station staff have aided considerably in farmers' institute work during the year. A new hennery, which will be available for investigations when funds for this purpose have been provided, has been erected on the farm. The legislature of the State has recently appropriated $60,000 for a new agricultural building, which will greatly improve the facilities of the station and the college of agriculture. This is an encouraging indication that the people of the State appreciate the work of the station. It is hoped that funds will also be provided soon for the purpose of extending the investigations along lines which are now undeveloped for lack of means.

### LINES OF WORK.

The principal lines of work conducted at the Vermont Station during the past year were as follows: Chemistry—composition of potatoes, artichokes, etc., methods of analysis; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; botany—grasses and other forage crops, destruction of weeds, etc.; horticulture—propagation, pollenization, and hybridization of plums; diseases of plants; feeding experiments, and dairying.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 1,468.03 |
| Fees | 2,548.47 |
| Total | 19,016.50 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 100–107 and the Annual Report for 1903. Bulletins 101 and 104 are on commercial feeding stuffs, Bulletin 107 on commercial fertilizers, and the others on paying for separated cream at the creamery, the measurements of saw logs, maple-sap flow, and an abstract of the Sixteenth Annual Report.

## VIRGINIA.

### Virginia Agricultural Experiment Station, *Blacksburg*.[a]

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

### GOVERNING BOARD.

Board of Visitors: J. W. Southall (*Superintendent of Public Instruction*), *Richmond;* J. T. Brown,* *Brierfield;* D. M. Cloyd,* *Dublin;* J. B. Watkins,* *Hallsboro;* B. B. Brockenbrough, *Tappahannock;* J. F. Ryan, *Arcola;* W. B. Robertson,* *Plasterco;* J. S. Musgrave, *Pinopolis;* J. C. Carrington, *Charlotte.*

### STATION STAFF.

A. M. Soule, B. S. A., *Director.*
R. J. Davidson, M. A., *Chemist.*
H. L. Price, M. S., *Horticulturist.*
Wm. D. Saunders, *Dairy Husbandman.*
Meade Ferguson, Ph. D., *Bacteriologist.*
John Spencer, V. S., *Veterinarian.*
J. R. Fain, B. S., *Agronomist.*
Walter B. Ellett, Ph. D., *Assistant Chemist.*
Wm. A. P. Moncure, M. S., *Assistant Mycologist.*
P. O. Vanatter, *Field Experiments.*
Arthur P. Spencer, *Assistant Animal Husbandman.*
E. A. Smyth, M. A., *Consulting Biologist.*
D. O. Nourse, B. S., *Consulting Agronomist.*
Thos. L. Watson, Ph. D., *Consulting Geologist.*
C. I. Wade, *Treasurer.*
Mary G. Lacy, *Librarian.*
Mary K. Simpson, *Stenographer.*
Clement E. Craig, *Foreman of Field Experiments.*

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[a] Express and freight address, *Christiansburg Depot.*

### GENERAL OUTLOOK.

The Virginia Station is undergoing reorganization on a basis which should insure greater development and efficiency. The growth of the college with which the station is connected has been so rapid that it has been found necessary to organize it into several coordinate departments, with a dean in charge of each. A. M. Soule, formerly director of the Tennessee Station, has been chosen dean of the department of agriculture and director of the experiment station. The staff of the station has also been greatly strengthened by the appointment of a dairy husbandman, an agronomist, a field experimenter, an assistant animal husbandman, a consulting geologist, and a foreman of field experiments. Extensive investigations, which will require a period of at least ten years for their completion, have been mapped out. These include rotation experiments, selection and improvement of cereals, tests of legumes and other forage plants, a comprehensive geological and chemical survey of the soils of the State, and extensive investigations in animal husbandry, one of the topics of special importance in this connection being the economic production of export cattle. While much new work is being developed, it is planned to continue and strengthen all of the more important lines of work which have been in progress in previous years, including the investigations relating to the production of vinegar, the study of fermentation, canning of fruit, soil bacteriology, entomology, etc.

For the work in animal husbandry a large barn will be erected, the plans of which have now been completed. The last legislature of the State gave the college and station an appropriation of $165,000 for building purposes. Out of this it is planned to construct a handsome agricultural building, which will furnish better facilities for both the college and the station. W. B. Alwood, who has long been identified with the station and has conducted extensive cider investigations in cooperation with the Bureau of Chemistry of this Department, resigned during the year.

With its staff organized on broad and thoroughly up-to-date lines and with additional funds and other facilities for investigation, the Virginia Station is now in a better position than ever before to conduct investigations having as their basis the improvement of soils and other agricultural conditions in the State, and the promotion of stock growing, which is essential to any considerable improvement in the condition of Virginia farms.

### LINES OF WORK.

The principal lines of work conducted at the Virginia Station during the past year were as follows: Chemistry; geology; field experiments—study of forage plants, corn and other crops, tillage and manurial experiments, rotations; analysis of foods; inspection of orchards; horticulture; bacteriology—of milk and soils, critical study of nitrifying and denitrifying bacteria; feeding experiments—feeding steers, study of corn stover, wheat straw, cotton-seed hulls, etc., as substitutes for hay; veterinary science; entomology; cider and vinegar making; biology; and study of ferments.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| State appropriation | 25.00 |
| Miscellaneous | 191.90 |
| Total | 15,216.90 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 133–142 and 144–147. Bulletins 133–142 belong to the series of orchard studies, including a second report on the cherry orchard, spraying the plum orchard, notes on varieties of domestic plums, on the occurrence and treatment of fire blight in the pear orchard, an investigation into the character of cider apples in Europe and comparisons with American fruit, a consideration of the commercial handling of cider fruit—grinding and expressing the must, a consideration of the principles and technique involved in the fermentation and final finishing of ciders, the chemical composition of ciders, some observations on crown gall of apple trees, the lime-sulphur wash for the San José scale, and the bitter rot of apples. The other bulletins were on stock and poultry powders or condimental foods, forage plants, some notes on canning fruits and vegetables, bush fruits—second report.

## WASHINGTON.

### **Washington Agricultural Experiment Station,** ***Pullman.***

Department of Washington Agricultural College and School of Science.

#### GOVERNING BOARD.

Board of Regents: F. J. Barnard (*President*), *Seattle;* R. C. McCroskey* (*Vice-President*), *Garfield;* J. P. Sharp,* *Ellensburg;* U. L. Ettinger (*Treasurer*), *Colfax;* H. D. Crow,* *Spokane;* E. A. Bryan (*Secretary, ex officio*), *Pullman.*

### STATION STAFF.

E. A. Bryan, M. A., LL. D., *Director.*
E. E. Elliott, M. S., *Agriculturist.*
R. Kent Beattie, B. S., M. A., *Acting Botanist.*
Elton Fulmer, M. A., *Chemist for State Work.*
Sofus B. Nelson, D. V. M., *Veterinarian.*
H. S. Davis, PH. B., *Assistant Zoologist.*
George Severance, B. S., *Assistant Agriculturist.*
R. W. Thatcher, B. S., M. A., *Chemist.*
M. Rosenberger, D. V. M., *Assistant Veterinarian.*
A. L. Melander, M. S., *Assistant Entomologist.*
W. H. Lawrence, M. S., *Assistant Botanist, Entomologist.*
O. L. Waller, PH. M., *Irrigation Engineer.*

### GENERAL OUTLOOK.

During the past fiscal year no material changes have been made in the work of the Washington Station. The work in agronomy now includes a large number of breeding experiments with cereals in cooperation with the Bureau of Plant Industry of this Department. Tests are also being made of clover and alfalfa from different sources, and a dry-land alfalfa has been found which yielded over 4 tons per acre at the station. The veterinarian in connection with his investigations on poisonous plants has discovered a bacterium to which he attributes the supposed poisoning of sheep. He has isolated the bacterium and with it killed rabbits in which the characteristic lesions were formed. The horticulturist has been grafting tomatoes on different tomato stocks and on potatoes, testing the keeping qualities of fruit from different sources, carrying on pollination experiments, and studying the viability of pollen in different varieties of apples. In the study of plant diseases special attention has been given to a new tomato blight which prevails in all the warm valleys, and to devising an effective and efficient treatment for smut on wheat. An organism which is supposed to be the cause of crown gall has been discovered.

The chemist is giving attention especially to studies of grasses and forage plants and of hay from different sources. Hay grown on the eastern side of the State brings a higher price than that grown on the western side, and an effort is being made to discover the cause. He has found in connection with investigations on the effect of feeding cotton-seed meal to pigs on the quality of lard produced that such lard gives the characteristic cotton-seed oil reaction. Irrigation investigations in cooperation with this Office have been continued.

The station has made some progress during the year in differentiating college and station work on the farm. It is also doing more and better work than formerly, but is in need of a more effective organization and of larger funds for the general expenses of investigation.

### LINES OF WORK.

The principal lines of work conducted at the Washington Station during the past year were as follows: Chemistry—methods of analysis, chemical studies of hay, forage crops for silage, fertilizers, foods, and dairy products; botany—study of crown gall, black spot, canker, tomato blight, pear blight, grain smuts; bacteriology; soils—subsoiling and soil treatment; field experiments—tests of grasses for pasture, varieties of oats, barley, emmer, spelt, and einkorn, rotations, time of seeding, sugar beets; horticulture—cover crops and fertilizers for orchards, spraying for apple scab, protection from frost, varieties of fruits and vegetables, selection of nursery stock; plant breeding—cereals, clover, alfalfa, and vetches; diseases of plants; feeding and breeding experiments—cattle, swine, and sheep; veterinary science—control of the squirrel pest, poisonous effect of certain plants on sheep, influence of feeding fungi to horses, glanders, tuberculosis of cattle, heaves, study of influence of animal fat as a conserver of heat; entomology—study of the codling moth in cooperation with other northwestern stations, insects affecting cereals, San José scale and remedies for the same, parasitic diseases of crickets; dairying; and irrigation.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products, including balance from previous year | 830.78 |
| Total | 15,830.78 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 54–60 and the Annual Report for 1902. The subjects treated in the bulletins were as follows: The formalin treatment for wheat and oat smut, Washington soils, spraying for the San José scale with modifications of the sulphur-salt-lime wash, a home vegetable garden in the Palouse country, experiments in feeding swine, root diseases of fruit and other trees caused by toadstools, and a report on the range conditions of central Washington.

## WEST VIRGINIA.

**West Virginia Agricultural Experiment Station,** *Morgantown.*

Department of West Virginia University.

### GOVERNING BOARD.

Board of Regents: E. M. Grant, *Morgantown;* C. E. Haworth, *Huntington;* L. J. Williams, *Lewisburg;* C. M. Babb, *Falls;* J. R. Trotter, (*President*), *Buckhannon;* D. C. Gallaher, *Charleston;* J. B. Finley, *Parkersburg;* S. H. Bowman, *Phillipi.*

### STATION STAFF.

J. H. Stewart, M. A., LL. D., *Director; Agriculturist.*
B. H. Hite, M. S., *Chemist.*
J. L. Sheldon, Ph. D., *Bacteriologist.*
Theodore Imbach, *Assistant Horticulturist.*
W. E. Rumsey, B. S. Agr., *Assistant Entomologist.*
C. D. Howard, B. S., *Associate Chemist.*
F. B. Kunst, *Assistant Chemist.*
Horace Atwood, M. S. Agr., *Assistant Agriculturist.*
T. C. Johnson, A. M., *Assistant Horticulturist.*
W. M. Watson, *Stenographer.*
M. A. Stewart, *Librarian.*
W. J. White, *Auditor, Clerk.*
A. R. Whitehill, Ph. D., *Treasurer.*
A. L. Post, A. M., *Assistant Bacteriologist.*
F. F. Grout, B. S., *Assistant Chemist.*

### GENERAL OUTLOOK.

The West Virginia Station has made substantial progress during the past fiscal year in developing its investigations along agricultural, chemical, and pathological lines. The agricultural department continues to give prominence to its poultry investigations. It has made an exhaustive study of the production of fertile eggs and of their artificial incubation, and is now studying means of rearing chicks successfully, giving attention to breeds, heating devices, exercise, air space, and the management and construction of brooder houses. For a number of years small movable colony houses for laying hens have been in successful use, and more recently these have been adapted to the rearing of very young chickens by the installation of cheap heating devices (Pl. VI, fig. 2). From the standpoint of health and economy this method has yielded excellent results. The department of agriculture is also conducting field and plat experiments, the latter consisting largely of fertilizer and inoculation experiments with leguminous plants. The work with legumes is conducted in cooperation with the Bureau of Plant Industry of this Department. A brick silo has recently been completed and filled, to be used in connection with feeding work.

The chemist is continuing his investigations on the possibility of preserving fruit juices, fruits, and other substances by subjecting them to high pressure. The possibility of thus preserving such substances has been quite clearly demonstrated and a wide and interesting field of purely scientific investigation has been opened up. Whether practical application can be made of the principle involved in these experiments remains to be demonstrated. An investigation is being made to discover a process for the fixation of atmospheric nitrogen, in connection with which a number of pieces of special apparatus have been devised. The department of chemistry is continuing its study of insecticides and fungicides, and has begun an examination of the mineral and drinking waters of the State.

During the past year some work in vegetable pathology has been developed, and a thorough survey of the State has been made to discover the different prevalent diseases and pests of fruits, vegetables, and other economic plants. In some of the work on diseases of fruits and vegetables the horticulturist and vegetable pathologist are cooperating. The station is also cooperating with the State geological survey in studies relating to the agricultural resources of the State, in connection with which a soil map of the State will be prepared. All of the analytical work of the survey is done at the station under the supervision of the chemist. During the past year the station and the State superintendent of public schools have been cooperating in an effort to improve some of the buildings and grounds of the rural schools throughout the State.

The inspection of fertilizers and nurseries under the direction of station officers has been continued as heretofore. This work has brought the station workers into intimate contact with a large number of farmers and has apparently awakened considerable popular interest in the investigations of the station. This has been noted especially in a largely increased correspondence. The station is conducting a considerable amount of work of scientific and practical value, but there is need of additional investigations in animal husbandry, horticulture, and several other lines, and it is hoped that funds will be provided for these purposes.

### LINES OF WORK.

The principal lines of work conducted at the West Virginia Station during the past year were as follows: Chemistry—study of insecticides and fungicides, analytical work with feeding stuffs and waters, study of pressure as a preservative and of a process for the fixation of atmospheric nitrogen, methods of analysis; analysis and control of fertilizers; inspection of orchards and nurseries; soils—study of fertility by use of rotations, green manures, commercial fertilizers and barnyard manure, study of acid soils, soils of orchard sections, etc.; field experiments—variety tests of cereals and legumes, fertilizer experiments with buckwheat, pastures, and meadows; horticulture—adaptability of mountain-glade lands for truck crops, cranberries and other fruits, study of causes of winterkilling in peach orchards, forcing experiments with vegetables, study of effect of cross pollination of the apple and other fruits, of insecticides and fungicides, and of diseases of fruits and vegetables; feeding experiments with sheep; poultry experiments—production of meat and eggs, incubation, experiments to improve flavor of meat and eggs of domesticated fowls; and entomology—insects injurious to orchards, orchard products, and forest trees.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Fees | 9,596.73 |
| Farm products | 2,403.27 |
| Miscellaneous | 135.06 |
| Total | 27,135.06 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 84–91 and Annual Reports for 1901 and 1902. The bulletins included two accounts of fertilizer inspection and other subjects, as follows: Experiments with buckwheat and oats, cranberries in West Virginia, greenhouses, poultry experiments, rural water supply and sheep-feeding experiments. There were also received circulars of information on the muskmelon blight, treatment of the San José scale, and the striped cucumber beetle.

## WISCONSIN.

### Agricultural Experiment Station of the University of Wisconsin, *Madison.*

Department of the University of Wisconsin.

### GOVERNING BOARD.

Board of Regents: George F. Merrill (*President*), *Ashland;* President of University,* *Madison;* State Superintendent of Instruction (*ex officio*), *Madison;* James C. Kerwin * (*Vice-President*), *Neenah;* E. F. Riley (*Secretary*), *Madison;* William F. Vilas, *Madison;* Almah J. Frisby, *Milwaukee;* H. C. Taylor,* *Orfordville;* L. S. Hanks, *Madison;* D. T. Parker,* *Fennimore;* James M. Pereles, *Milwaukee;* Arthur J. Puls, *Milwaukee;* M. C. Mead,* *Plymouth;* Edward Evans, *La Crosse;* O. E. Clark, *Appleton;* August J. Myrland,* *Grantsburg.*

### STATION STAFF.

W. A. Henry, D. Agr., D. Sc., *Director.*
S. M. Babcock, Ph. D., LL. D., *Assistant Director; Chief Chemist.*
H. L. Russell, Ph. D., *Bacteriologist.*
E. H. Farrington, M. S., *Dairy Husbandman.*
A. R. Whitson, B. S., *Agricultural Physicist.*
E. P. Sandsten, Ph. D., *Horticulturist.*
G. C. Humphrey, B. S., *Animal Husbandman.*
F. W. Woll, Ph. D., *Chemist.*
R. A. Moore, *Agronomist.*
A. S. Alexander, M. D. C., V. S., *Veterinarian.*
G. N. Knapp, B. S., *Agricultural Engineer.*
C. W. Stoddart, A. M., *Assistant Agricultural Physicist.*
E. G. Hastings, M. S., *Assistant Bacteriologist.*
W. S. Brown, B. S. A., *Assistant Horticulturist.*
W. J. Carson, B. S. A., *Assistant Dairy Husbandman.*
J. C. Brown, M. S., *Assistant in Agricultural Chemistry.*
G. A. Olson, B. S., *Assistant in Agricultural Chemistry.*
J. G. Fuller, B. S., *Assistant Animal Husbandman.*
A. L. Stone, *Assistant Agronomist.*
Frank Kleinheinz, *Shepherd.*
L. H. Adams, *Farm Superintendent.*
Ida Herfurth, *Executive Clerk.*
Sophie M. Briggs, *Librarian.*

### GENERAL OUTLOOK.

The Wisconsin Station has made considerable progress during the past year in developing its work along lines previously established.

The investigations on the cold curing of cheese have been closed and the results published. The influence of these investigations is now seen in the establishment of several commercial plants for curing cheese at low temperatures. The investigations on moor lands to determine the causes of unproductiveness have been resumed and greatly extended. There continues to be a large amount of work in animal husbandry, to which have been added feeding experiments with pigs to test fresh and fermented corn meal and cotton-seed meal combined, with reference to the safety of feeding the fermented meals. The bacteriologist is studying the bacterial development of nodules on legumes, and soil bacteria. A new department of agricultural engineering has been established in connection with the college and station and put in charge of G. N. Knapp, late of the United States Geological Survey, who has taken up a study of systems of ventilation for barns.

The Wisconsin Station continues to cooperate with the Bureau of Plant Industry of this Department in experiments on cereals, with the Bureau of Chemistry on the effect of environment on the chemical composition of sugar beets, and with this Office on irrigation experiments. It is also cooperating very extensively with farmers through the Agricultural Experiment Association, which has a membership of nearly 600 members, mostly young men who have attended short courses at the university. This work consists largely in testing the supposed valuable varieties of farm seeds and growing new crops. At present about 200 members are growing improved varieties of corn and about 500 are endeavoring to grow alfalfa. The association has an appropriation of $1,000 from the legislature, and 500 copies of its report are published by the State.

The station is conducting extensive experiments with cranberries, with an appropriation of $2,500 a year from the State. A large plant has been prepared with reservoir and canals for irrigation and a scheme for drainage. The water for irrigation is pumped from the drainage canal, and so can be used over and over. A part of this work is in cooperation with this Office. The station is also conducting tobacco investigations at several places, with a State appropriation, and is demonstrating the value of spraying potatoes, testing dairy cattle, and doing other extension work, which brings it into close touch with the farmers of the State.

The facilities of the station have been considerably improved during the past year by the extension of waterworks to the agricultural buildings, the rebuilding of the greenhouses and the addition of a new greenhouse, the improvement of facilities for work in agricultural physics, the purchase of land adjacent to the "hill farm," and the building of cement walks and macadam roads on the college grounds.

The Wisconsin Station continues to pursue a very aggressive course in working out the problems of practical agriculture in the State and also in studying the underlying principles of agriculture. The new department of agricultural engineering bids fair to be a most important and useful one in the State, and the development of the work in agronomy is taking a very practical form, which is interesting a large number of intelligent young farmers. The university has reached a point where the need is becoming more apparent of increased appropriations to carry on the work of the college of agriculture and at the same time maintain the station work on the high plane which it has occupied.

### LINES OF WORK.

The principal lines of work conducted at the Wisconsin Station during the past year were as follows: Chemistry—studies of silage and of the effect of nitrates on the protein content of corn, oats, rape, and cowpeas; bacteriology—studies of nodules of legumes, soil bacteria, pasteurization; soils—pot and field experiments with muck; field experiments—cereals and forage crops; horticulture—studies of seedling apples and plums, effects of pinching back raspberries, etc.; feeding experiments—horses, cattle, sheep, and swine; dairying—cheese ripening at low temperatures, experiments with skim milk, condensed milk, and cream; drainage; irrigation; and agricultural engineering.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000 |
| State appropriation | 19,000 |
| Fees | 1,800 |
| Total | 35,800 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 100–113 and the Annual Report for 1903. Bulletins 100, 106, 109, and 113 contain analyses and law concerning fertilizers and feeding stuffs. The other bulletins are on the following subjects: Shrinkage of cold-cured cheese during ripening; studies in milk production; soiling crops for dairy cows in Wisconsin; the food requirements of pigs from birth to maturity; the improvement of home grounds; official tests of dairy cows, 1902–3; trees and shrubs for shade and ornament; spraying fruit trees; grain smut and its prevention; and alfalfa in Wisconsin. The Annual Report contains a report of the director summarizing the work of the station, a description of the new agricultural building, a history of the college and station, an account of a comparison of whole corn and corn meal for fattening pigs, and summaries of the work of the station during the period 1893–1903 on the following subjects: The feeding value of rape and other succulent foods; experiments in lamb feeding; breeding lambs for market; the flock and its management; feeding trials with pigs; experiments in feeding and management of dairy cows; testing cows at the farm; tests of dairy cows; methods and apparatus for testing milk and milk products; pasteurization as applied to butter making; preservation of milk for direct use by pasteurization; conditions affecting the consistency of milk—means of restoring consistency of pasteurized cream; experimental work on methods of cheese manufacture; investigations regarding the curing of cheese; galactase, the inherent digestive enzym of milk; cold curing of cheese; experiments in paraffining cheese; special series of cheese bulletins; bacteriology of cheese; dairy bacteriological problems; miscellaneous bacteriological investigations; causes of silage fermentation; investigations on bovine tuberculosis; anthrax in Wisconsin; black rot of cabbage; experiments with grain and forage plants, 1899–1903; treatment of seed grain for the prevention of smut; experiments with sugar beets; report of the division of feeding stuffs and fertilizers; miscellaneous chemical investigations; irrigation in humid climates; studies on the improvement of marsh soils; studies on the development and distribution of nitrates and total water-soluble salts in field soils; problems in farm mechanics; native plums; the origin of development of fruit buds; the treatment of seed oats for the prevention of smut; miscellaneous horticultural work; report of nursery inspection for the State of Wisconsin.

## WYOMING.

### Wyoming Agricultural Experiment Station, *Laramie.*

Department of the University of Wyoming.

#### GOVERNING BOARD.

Board of Trustees: Otto Gramm * (*President*), *Laramie;* T. F. Burke (*Vice-President*), *Cheyenne;* Grace R. Hebard * (*Secretary*), *Cheyenne;* J. C. Davis (*Treasurer*), *Rawlins;* A. C. Jones,* *Laramie;* W. G. Aber, *Wolf;* Bessie A. Stone, *Evanston;* H. L. Stevens,* *Laramie;* Harriet Knight, *Cheyenne;* A. J. Mokler, *Casper;* T. T. Tynan (*State Superintendent of Public Instruction, ex officio*), *Cheyenne;* F. M. Tisdel (*President of University, ex officio*), *Laramie.*

### STATION STAFF.

B. C. Buffum,* M. S., *Director, Agriculturist.*
Aven Nelson, A. M., *Botanist.*
C. B. Ridgaway, M. A., *Physicist.*
H. G. Knight, A. M., *Chemist.*
Grace R. Hebard, PH. D., *Secretary.*
George E. Morton, M. L., *Assistant in Animal Industry.*
N. Albin Nelson, *Assistant Meteorologist.*
Frank E. Hepner, PH. G., B. S., *Assistant Chemist.*
E. L. Case, *Stenographer.*

### GENERAL OUTLOOK.

The work of the Wyoming Station during the past fiscal year has been mainly a continuation of investigations previously inaugurated, including experiments in selecting wheat; the rotation of crops; the use of legumes for green manuring; studies of alfalfa, grasses, and forage plants; experiments with potatoes, including the control of Rhizoctonia; the production of rape, alfalfa, and peas for feeding sheep and hogs; experiments on the water requirements for a maximum crop of oats, and fiber investigations in cooperation with the Bureau of Plant Industry of this Department. Investigations on the duty of water in producing oats and other irrigation investigations have been conducted in cooperation with this Office. A lamb-feeding experiment has been made, in which 300 animals were divided into five lots and given a variety of rations. Those pasturing on field peas alone did as well as those fed on alfalfa and corn. It is thought that peas will prove an economical feed for fattening lambs, provided corn is used for finishing. These experiments are to be repeated. A number of cattle and horses have been purchased for the purpose of beginning breeding experiments.

Much attention has necessarily been given to the reorganization of the station work and the adaptation of the penitentiary lands and buildings recently acquired by the station to the needs of station work. Additions of considerable importance have been made to the station live stock and of minor importance to its other equipment. With more liberal funds for the extension of its investigations the station would be in much better condition than heretofore.

### LINES OF WORK.

The principal lines of work conducted at the Wyoming Station during the past year were as follows: Botany; range improvement; meteorology; soils—rotations, continuous cropping, cultural experiments, renovators, study of soil characteristics; fertilizers; field experiments—variety tests and cultural experiments with cereals, forage crops, and garden vegetables; analysis of foods; feeding experiments—horses, milch cows, pigs, poultry, range sheep, and lambs; and irrigation—measurement of water on the station farm, plat experiments, effects of irrigation on alkali.

### INCOME.

The income of the station during the past fiscal year was as follows:

| | |
|---|---|
| United States appropriation | $15,000.00 |
| Farm products | 2,168.57 |
| Total | 17,168.57 |

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

### PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 59–61, Index Bulletin C, and the Annual Report for 1903. The subjects treated in the bulletins include the wheat grasses of Wyoming, wheat growing on the Laramie plains, and seepage investigations in the valley of the Laramie River.

# PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ISSUED DURING 1904.[a]

## EXPERIMENT STATION RECORD.

| Title. | Editor. |
|---|---|
| Experiment Station Record, Vol. XV (1903–4), Nos. 5-12 | E. W. Allen. |
| Experiment Station Record, Vol. XVI (1904–5), Nos. 1–4 | Do. |
| General Index to Experiment Station Record | Do. |

## ANNUAL REPORTS.

| Title. | Author. |
|---|---|
| Report of the Director of the Office of Experiment Stations for 1904 | A. C. True. |
| Annual Report of the Office of Experiment Stations for the year ended June 30, 1903. | Do. |

## ARTICLES IN THE YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

| | |
|---|---|
| The Farmers' Institutes (Yearbook, 1903, pp. 149–158) | John Hamilton. |
| Wheat Flour and Bread (Yearbook, 1903, pp. 347–362) | Harry Snyder and C. D. Woods. |
| Preparing Land for Irrigation (Yearbook, 1903, pp. 239–250) | R. P. Teele. |

## BULLETINS.

| Number. | Title. | Author. |
|---|---|---|
| Bulletin 141 | Experiments on Losses in Cooking Meat, 1900–1903 | H. S. Grindley and T. Mojonnier. |
| Bulletin 142 | Proceedings of the Seventeenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington D. C., November 17–19, 1903. | A. C. True, W. H. Beal, and H. C. White. |
| Bulletin 143 | Studies on the Digestibility and Nutritive Value of Bread at the Maine Agricultural Experiment Station, 1899–1903. | C. D. Woods and L. H. Merrill. |
| Bulletin 144 | Irrigation in Northern Italy, Part 1 | Elwood Mead. |
| Bulletin 145 | Preparing Land for Irrigation and Methods of Applying Water. Prepared by the Agents of Irrigation Investigations. | |
| Bulletin 146 | Current Wheels, Their Use in Lifting Water for Irrigation. Prepared in the Office of Experiment Stations, Irrigation Investigations. | |
| Bulletin 147 | Report on Drainage Investigations, 1903 | C. G. Elliott. |
| Bulletin 148 | Report on Irrigation Investigations in Humid Sections of the United States in 1903. | Elwood Mead et al. |
| Bulletin 149 | Studies of the Food of Maine Lumbermen | C. D. Woods and E. R. Mansfield. |
| Bulletin 150 | Dietary Studies at the Government Hospital for the Insane, Washington, D. C. | H. A. Pratt and R. D. Milner. |

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[a] A list of publications issued by the Office from its organization to 1899 was published in Bulletin No. 80, p. 508, of the Office of Experiment Stations, and lists of those issued during 1902 and 1903 in the following Annual Reports of the Office of Experiment Stations: Annual Report 1902, p. 192; Annual Report 1903, p. 203.

*Publications of the Office of Experiment Stations issued during 1904*—Continued.

FARMERS' BULLETINS.[a]

| Number. | Title. | Author. |
|---|---|---|
| Bulletin 186 | Experiment Station Work, XXIII | W. H. Beal, editor. |
| Bulletin 187 | Drainage of Farm Lands | C. G. Elliott. |
| Bulletin 190 | Experiment Station Work, XXIV | W. H. Beal, editor. |
| Bulletin 192 | Barnyard Manure | W. H. Beal. |
| Bulletin 193 | Experiment Station Work, XXV | W. H. Beal, editor. |
| Bulletin 202 | Experiment Station Work, XXVI | Do. |
| Bulletin 203 | Canned Fruit, Preserves, and Jellies | Maria Parloa. |
| Bulletin 210 | Experiment Station Work, XXVII | W. H. Beal, editor. |

CIRCULARS.

| | | |
|---|---|---|
| Circular 57 | Supplemental Report on Drainage in the Fresno District, California. | C. G. Elliott. |
| Circular 58 | Irrigation in the Valley of Lost River, Idaho | A. E. Wright. |

## STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS DURING 1904.[b]

ALABAMA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 127 | Alfalfa in Alabama | J. F. Duggar. |
| Bulletin 128 | Feeding and Grazing Experiments with Beef Cattle | J. F. Duggar, R. W. Clark, and J. M. Jones. |
| Bulletin 129 | The Mexican Cotton Boll Weevil | E. M. Wilcox. |

ALABAMA CANEBRAKE STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 20 | Alfalfa, Sorghum, Soy Beans, and other Forage Plants | J. F. Duggar and J. M. Richeson. |
| 1904. | | |
| Bulletin 21 | Experiments with Cotton and Corn in 1903 | Do. |

ALASKA STATIONS.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report | Annual Report, 1903 | C. C. Georgeson. |

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[a] These are published as a part of a general series issued by the United States Department of Agriculture.

[b] A list of the publications issued by the stations from 1875 to 1899 was published in Bulletin 80, p. 512, of the Office of Experiment Stations, and lists of those issued in subsequent years in the following bulletins and annual reports of the Office of Experiment Stations: 1900, Bulletin 88, p. 89; 1901, Bulletin 111, p. 74; 1902, Annual Report, 1902, p. 194; and 1903, Annual Report, 1903, p. 205.

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

## ARIZONA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 47 | Timely Hints for Farmers | |
| Annual Report | Fourteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 48 | Relation of Weather to Crops | A. J. McClatchie. |
| Bulletin 49 | Cost of Pumping for Irrigation | S. M. Woodward. |

## ARKANSAS STATION.

| | | |
|---|---|---|
| 1902. | | |
| Annual Report | Fifteenth Annual Report, 1902 | |
| 1903. | | |
| Bulletin 79 | Peach Growing in Arkansas | E. Walker. |
| Bulletin 80 | Cowpea Hay | C. L. Newman. |
| 1904. | | |
| Bulletin 81 | Fertilizers | A. M. Muckenfuss. |
| Bulletin 82 | Live-stock Sanitation in Arkansas | R. R. Dinwiddie. |
| Bulletin 83 | Broom Corn Suggestions | C. L. Newman. |
| Bulletin 84 | Peanuts | Do. |

## CALIFORNIA STATION.

| | | |
|---|---|---|
| 1903. | | |
| Report | Report, 1902-3 | |
| 1904. | | |
| Circular 9 | Report on Asparagus Rust Investigation | R. E. Smith. |
| Circular 10 | Reading Course in Economic Entomology | C. W. Woodworth. |
| Circular 11 | Fumigation Practice | Do. |
| Circular 12 | Silk Culture | E. H. Twight and C. S. Ash. |
| Bulletin 155 | Directions for Spraying for the Codling Moth | C. W. Woodworth. |
| Bulletin 156 | Fowl Cholera | A. R. Ward. |
| Bulletin 157 | Commercial Fertilizers | G. Roberts. |
| Bulletin 158 | California Olive Oil: Its Manufacture | G. W. Shaw. |
| Bulletin 159 | Contribution to the Study of Fermentation | E. H. Twight and C. S. Ash. |
| Bulletin 160 | The Hop Aphis | W. T. Clarke. |
| Bulletin 161 | Tuberculosis in Fowls | A. R. Ward. |

## COLORADO STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 85 | Cantaloupe Seed | P. K. Blinn. |
| Bulletin 86 | Crown Gall | W. Paddock. |
| 1904. | | |
| Bulletin 87 | Cattle Raising on the Plains | J. E. Payne. |
| Bulletin 88 | Dairying on the Plains | Do. |
| Bulletin 89 | Wheat Raising on the Plains | Do. |
| Bulletin 90 | Unirrigated Alfalfa on Upland | Do. |
| Bulletin 91 | Potato Failures | F. M. Rolfs. |
| Bulletin 92 | Large Potato Vines and No Potatoes | W. Paddock. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

CONNECTICUT STATE STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report.... | Eighth Report on Food Products. (Annual Report, 1903, Part II.) | E. H. Jenkins et al. |
| | Third Report of the State Entomologist. (Annual Report, 1903, Part III). | W. E. Britton. |
| | Report of the Station Botanist. (Annual Report, 1903, Part IV). | G. P. Clinton. |
| | Feeding Stuffs, Fertilizing Orchards, Seed Tests, Tobacco Work, Index. (Annual Report, 1903, Part V.) | E. H. Jenkins. |
| 1904. | | |
| Bulletin 145 ........ | Commercial Feeding Stuffs in the Connecticut Market .. | A. L. Winton et al. |
| Bulletin 146 ........ | San José Scale Insect Experiments in 1904 ................ | W. E. Britton and B. H. Walden. |
| Forestry Circ. 1.... | Forestry for Farmers of Connecticut ........................ | |
| Annual Report.... | Commercial Fertilizers. (Annual Report, 1904, Part I.) . | |

CONNECTICUT STORRS STATION.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report.... | Fifteenth Annual Report, 1902-3.......................... | |
| 1904. | | |
| Bulletin 28 ........ | Dairy Observations ........................................ | C. L. Beach. |
| Bulletin 29 ........ | Records of a Dairy Herd for Five Years .................. | Do. |
| Bulletin 30 ........ | Spraying Notes for 1903.................................. | E. R. Bennett. |
| Bulletin 31 ........ | The Food Value of a Pound of Milk Solids ................ | C. L. Beach. |
| Bulletin 32 ........ | Protecting Cows from Flies................................ | C. L. Beach and A. B. Clark. |

DELAWARE STATION.

| | | |
|---|---|---|
| 1904. | | |
| Bulletin 62 ........ | Pruning the Peach ........................................ | C. P. Close. |
| Bulletin 63 ........ | Notes on Fungus Diseases in Delaware.................. | F. D. Chester and C. O. Smith. |
| Bulletin 64 ........ | Some Experiences with the Lime, Sulphur, and Salt Washes. Two Common Scale Insects. | C. O. Houghton. |
| Bulletin 65 ........ | The Bacteriological Analysis of Soils ..................... | F. D. Chester. |

FLORIDA STATION.

| | | |
|---|---|---|
| 1902. | | |
| Annual Report.... | Annual Report, 1902 ........................................ | |
| 1904. | | |
| Bulletin 69 ........ | Cultivation of Citrus Groves .............................. | H. H. Hume. |
| Bulletin 70 ........ | Pineapple Culture, II. Varieties .......................... | H. H. Hume and H. K. Miller. |
| Bulletin 71 ........ | Japanese Persimmons ...................................... | H. H. Hume and F. C. Reimer. |
| Bulletin 72 ........ | Feeding Horses and Mules on Home-grown Feed Stuffs .. | C. M. Conner. |
| Bulletin 73 ........ | The Honey Peach Group .................................. | F. C. Reimer. |
| Bulletin 74 ........ | Anthracnose of the Pomelo ................................ | H. H. Hume. |

GEORGIA STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 61 ........ | The Fig in Georgia......................................... | H. N. Starnes. |
| Bulletin 62 ........ | Corn Culture................................................ | R. J. Redding. |
| Bulletin 63 ........ | Cotton Culture.............................................. | Do. |
| Annual Report.... | Sixteenth Annual Report, 1903 ........................... | |

*Station publications received by the Office of Experiment Stations during 1904*—**Continued.**

### HAWAII STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report | Annual Report, 1903 | J. G. Smith. |
| 1904. | | |
| Bulletin 5 | A Sugar-cane Leaf-hopper in Hawaii | D. L. Van Dine. |
| Bulletin 6 | Mosquitoes in Hawaii | Do. |
| Bulletin 7 | The Banana in Hawaii | J. E. Higgins. |

### IDAHO STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report | Annual Report, 1903 | |
| 1904. | | |
| Bulletin 39 | Some Experiments with Fungus Diseases in 1903 | L. F. Henderson. |
| Bulletin 40 | Winter Spraying for the Apple Aphis | J. M. Aldrich. |
| Bulletin 41 | Grasshopper and Cricket Outbreaks | Do. |
| Bulletin 42 | Experiments in Pig Feeding | H. T. French. |
| Bulletin 43 | Planting the Apple Orchard | L. B. Judson. |
| Bulletin 44 | Alkali and the Treatment of Alkali Lands | J. S. Burd. |
| Bulletin 45 | Trap Rocks of Palouse Region as Road Material | C. N. Little and W. L. Zeigler. |

### ILLINOIS STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 89 | Notes on the Insecticide Use of the Gasoline Blast Lamp. | S. A. Forbes. |
| Bulletin 90 | Fattening Steers of the Various Market Grades | H. W. Mumford. |
| Bulletin 91 | Preventing Contamination of Milk | W. J. Fraser. |
| Bulletin 92 | City Milk Supply | Do. |
| Circular 73 | Milk Production at the University of Illinois | Do. |
| 1904. | | |
| Bulletin 93 | Soil Treatment for Peaty Swamp Lands, Including Reference to Sand and "Alkali" Soils. | C. G. Hopkins. |
| Bulletin 94 | Nitrogen Bacteria and Legumes | Do. |
| Bulletin 95 | The More Important Insect Injuries to Indian Corn | S. A. Forbes. |
| Circular 74 | Directions for the Breeding of Corn | L. H. Smith. |
| Circular 75 | Feeding Dairy Cows | W. J. Fraser. |
| Circular 76 | Improvement of Dairy Herds | H. A. Hopper. |
| Circular 77 | Records of Individual Cows on Dairy Farms | A. J. Glover. |
| Circular 78 | Clean Milk | W. J. Fraser. |
| Circular 79 | Present Methods of Beef Production | H. W. Mumford and L. D. Hall. |
| Circular 80 | Power Spraying | J. C. Blair. |
| Circular 81 | Selection of Seed in Potato Growing | E. M. East. |
| Circular 82 | The Physical Improvement of Soils | J. G. Mosier. |

### INDIANA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 97 | On the Value of Distillery Dried Grains as a Food for Work Horses. | C. S. Plumb. |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 98 | Three Edible Toadstools | J. C. Arthur. |
| Bulletin 99 | Tests of Small Fruits | J. Troop. |
| Bulletin 100 | Diseases of Swine | R. A. Craig and A. W. Bitting. |
| Annual Report | Seventeenth Annual Report, 1904 | |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

IOWA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1904. | | |
| Bulletin 74 | Breakfast Foods | J. B. Weems and C. E. Ellis. |
| Bulletin 75 | The Feeding Value of Soft Corn for Beef Production | W. J. Kennedy et al. |
| Bulletin 76 | The Moisture Content of Butter and Methods of Controlling It. | G. L. McKay and C. Larsen. |
| Bulletin 77 | Selecting and Preparing Seed Corn | P. G. Holden. |
| Bulletin 78 | Drainage Conditions in Iowa | W. H. Stevenson and G. I. Christie. |
| | Notes and Tables on Drainage Engineering | L. E. Ashbaugh. |
| Bulletin 79 | Experiments in Beef Production | W. J. Kennedy et al. |

KANSAS STATION.

| | | |
|---|---|---|
| 1904. | | |
| Bulletin 120 | Tests of Forest Trees | A. Dickens and G. O. Greene. |
| Bulletin 121 | Treatment and Utilization of Flood-damaged Lands | A. M. Ten Eyck, H. F. Roberts, and A. Dickens. |
| Bulletin 122 | Blackleg and Vaccination | N. S. Mayo and C. L. Barnes. |
| Bulletin 123 | Crop Experiments in 1903 | A. M. Ten Eyck and V. M. Shoesmith. |
| Bulletin 124 | Experiments in Feeding Steers and in Breeding and Feeding Pigs. | D. H. Otis et al. |
| Bulletin 125 | Experiments with Dairy Cows | D. H. Otis. |

KENTUCKY STATION.

| | | |
|---|---|---|
| 1900. | | |
| Annual Report | Thirteenth Annual Report, 1900 | |
| 1903. | | |
| Bulletin 110 | Nursery Inspection and San José Scale | H. Garman. |
| Bulletin 111 | The Hessian Fly in 1902-3 | Do. |
| Bulletin 112 | Commercial Fertilizers | M. A. Scovell et al. |

LOUISIANA STATIONS.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 76 | Analyses of Commercial Fertilizers and Paris Green | W. C. Stubbs and C. H. O'Rourke. |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 77 | Rice | W. C. Stubbs, W. R. Dodson, and C. A. Browne, jr. |
| Bulletin 78 | Comparative Results of Seedling Sugar Canes, D. 74 and D. 95, with Our Home Sugar Canes (Louisiana Striped and Louisiana Purple). | W. C. Stubbs and R. E. Blouin. |
| Bulletin 79 | Results of Experiments with Nodule Disease of the Intestines of Sheep. | W. H. Dalrymple. |

MAINE STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 96 | Plant-house Aleurodes | L. R. Cary. |
| Bulletin 97 | Notes and Experiments upon the Wheats and Flours of Aroostook County. | C. D. Woods and L. H. Merrill. |
| Bulletin 98 | Potato Experiments in 1903. Notes on the Angora Goat. | C. D. Woods. |
| | The Preservation of Hen Manure | C. D. Woods and J. M. Bartlett. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

MAINE STATION—Continued.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 99 | Finances, Meteorology, Index | |
| Annual Report | Nineteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 100 | Poultry Management | G. M. Gowell. |
| Bulletin 101 | Fertilizer Inspection | C. D. Woods and J. M. Bartlett. |
| Bulletin 102 | Feeding-stuff Inspection | Do. |
| Bulletin 103 | Entire-wheat Flour | C. D. Woods and L. H. Merrill. |
| Bulletin 104 | A Study of Reciprocal Crosses | M. B. Cummings. |
| Bulletin 105 | Fertilizer Inspection | C. D. Woods and J. M. Bartlett. |
| Bulletin 106 | Soy Beans in Maine. Feeding Experiments with Cows. Alfalfa. | C. D. Woods. |
| Bulletin 107 | Home-mixed Fertilizers | Do. |
| Bulletin 108 | Brown-tail Moth and other Orchard Moths | Edith M. Patch. |

MARYLAND STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 90 | Experiments on the Control of San José Scale | T. B. Symons. |
| 1904. | | |
| Bulletin 91 | Experiments with Nitrogenous Fertilizers | H. J. Patterson. |
| Bulletin 92 | Notes on Apple Culture | C. F. Austin. |
| Bulletin 93 | Second Report on the Cause of Pithiness in Celery | C. F. Austin and T. H White. |
| Bulletin 94 | Systems for Keeping Milk and Butter Records | C. F. Doane. |
| Bulletin 95 | The Character of Milk during the Period of Heat | Do. |
| Bulletin 96 | Sweet Corn: Breeding, Growing, and Curing for Seed | A. Stabler and H. J Patterson. |
| Bulletin 97 | Relative Profits of Selling Milk, Cream, and Butter | C. F. Doane. |
| Bulletin 98 | Home-grown Protein as a Substitute for Purchased Feeds and Tests of Soiling Crops. | Do. |
| Annual Report | Seventeenth Annual Report, 1904 | |

MASSACHUSETTS STATION.

| | | |
|---|---|---|
| 1903. | | |
| Special Bulletin | The Dairy Law and Its Results | J. B. Lindsey et al. |
| Bulletin 93 | Concentrated Feeds | Do. |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 94 | Distillery and Brewery By-products | J. B. Lindsey et al. |
| Bulletin 95 | Analyses of Commercial Fertilizers and Manurial Substances. | C. A. Goessmann. |
| Bulletin 96 | Fungicides, Insecticides, and Spraying Calendar | G. E. Stone, H. T. Fernald, and F. A. Waugh. |
| Bulletin 97 | A Farm Woodlot | F. A. Waugh. |
| Bulletin 98 | Inspection of Concentrates | J. B. Lindsey et al. |
| Bulletin 99 | Dried Molasses-beet-pulp | Do. |
| | The Nutrition of Horses | J. B. Lindsey and P. H. Smith. |
| Bulletin 100 | Analyses of Commercial Fertilizers and Manurial Substances. | C. A. Goessmann. |
| Technical Bulletin 2. | The Graft Union | F. A. Waugh. |
| Meteorological Bulletins. | Meteorological Bulletins 181–185 | J. E. Ostrander and F. F. Henshaw. |
| | Meteorological Bulletins 186–192 | J. E. Ostrander and G. W. Patch. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### MICHIGAN STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report.... | Sixteenth Annual Report, 1903.............................. | |
| 1904. | | |
| Bulletin 211......... | Breakfast Foods .......................................... | F. W. Robison. |
| Bulletin 212......... | Seed Testing for Farmers.................................... | B. O. Longyear. |
| Bulletin 213......... | Small Fruits for 1904......................................... | L. R. Taft and M. L. Dean. |
| Bulletin 214......... | Tomatoes and Potatoes...................................... | Do. |
| Bulletin 215......... | Experiments with Sugar Beets in 1903....................... | C. D. Smith. |
| Bulletin 216......... | A Brief Review of Special Bulletins Nos. 24-26 ............ | Do. |
| Bulletin 217......... | Fertilizer Analyses .......................................... | F. W. Robison. |
| Bulletin 218......... | Some Essential Soil Changes produced by Micro-organisms | S. F. Edwards. |
| Bulletin 219......... | Soil Moisture: Its Importance and Management........... | J. A. Jeffery. |
| Bulletin 220......... | Dried Beet Pulp and Dried Molasses-beet-pulp for Fattening Sheep. | R. S. Shaw. |
| Special Bulletin 22. | The Crop of Corn ........................................... | J. A. Jeffery. |
| Special Bulletin 23. | A Preliminary Note on the Associative Action of Bacteria in the Souring of Milk and in Other Milk Fermentations. | C. E. Marshall. |
| Special Bulletin 24. | Insects Injurious to Fruits in Michigan..................... | R. H. Pettit. |
| Special Bulletin 25. | Fungus Diseases of Fruits in Michigan .................... | B. O. Longyear. |
| Special Bulletin 26. | Spraying Calendar........................................... | L. R. Taft and C. D. Smith. |
| Special Bulletin 27. | Report of the South Haven Substation for 1903 ............ | T. A. Farrand. |
| Special Bulletin 28. | Report of the Upper Peninsula Substation for the Year 1903. | L. M. Geismar and C. D. Smith. |
| Special Bulletin 29. | Additional Work upon the Associative Action of Bacteria in the Souring of Milk and in Other Milk Fermentations. | C. E. Marshall. |
| Annual Report.... | Seventeenth Annual Report, 1904 .......................... | |

### MINNESOTA STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 84.......... | Injurious Insects of 1903 ......................... .......... | F. L. Washburn. |
| Annual Report.... | Eleventh Annual Report, 1903.............................. | |
| 1904. | | |
| Bulletin 85.......... | Wheat and Flour Investigations............................ | H. Snyder. |
| Bulletin 86.......... | The Food Value of Sugar. The Digestive Action of Milk. | Do. |

### MISSISSIPPI STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 81 ......... | The Colorado Potato Beetle ................................. | G. W. Herrick. |
| Bulletin 82 ......... | Inspection and Analyses of Commercial Fertilizers ...... | W. F. Hand et al. |
| 1904. | | |
| Bulletin 83.......... | Report of Work at McNeill Branch Station for 1903....... | E. B. Ferris. |

### MISSOURI FRUIT STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 8........... | Commercial Orchards of South Missouri .................. | F. Horsfall. |
| Bulletin 9........... | Orchard Enemies............................................ | Do. |
| 1904. | | |
| Bulletin 10.......... | Fruit Buds .................................................. | P. Evans. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### NEW YORK STATE STATION—Continued.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 170, Revised. | Common Diseases and Insects Injurious to Fruits | S. A. Beach, V. H. Lowe, and F. C. Stewart. |
| Bulletin 242 | The Importance of Mineral Matter and the Value of Grit for Chicks. | W. P. Wheeler. |
| Bulletin 243 | Spray Mixtures and Spray Machinery | S. A. Beach, V. A. Clark, and O. M. Taylor. |
| Bulletin 244 | Director's Report for 1903 | W. H. Jordan. |
| Annual Report | Twenty-second Annual Report, 1903 | |
| 1904. | | |
| Bulletin 245 | Chemical Changes in the Souring of Milk and their Relations to Cottage Cheese. | L. L. Van Slyke and E. B. Hart. |
| Bulletin 246 | An Experiment in Shading Strawberries | O. M. Taylor and V. A. Clark. |
| Bulletin 247 | The Lime-sulphur-soda Wash for Orchard Treatment | P. J. Parrott, S. A. Beach, and H. O. Woodworth. |
| Bulletin 248 | New York Apples in Storage | S. A. Beach and V. A. Clark. |
| Bulletin 249 | A Swelling of Canned Peas Accompanied by a Malodorous Decomposition. | H. A. Harding and J. F. Nicholson. |
| Bulletin 250 | The Nature of the Principal Phosphorus Compound in Wheat Bran. | A. J. Patten and E. B. Hart. |
| Bulletin 251 | Vitality of the Cabbage Black-rot Germ on Cabbage Seed. | H. A. Harding F. C. Stewart, and M. J. Prucha. |
| Bulletin 252 | Report of Analyses of Commercial Fertilizers for the Spring and Fall of 1903. | W. H. Jordan, L. L. Van Slyke, and W. H. Andrews. |
| Bulletin 253 | Report of Analyses of Commercial Fertilizers for the Spring of 1904. | Do. |
| Bulletin 254 | Fall Spraying with Sulphur Washes | P. J. Parrott and F. A. Sirrine. |
| Bulletin 255 | Inspection of Feeding Stuffs | W. H. Jordan and F. D. Fuller. |

### NEW YORK CORNELL STATION.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report | Sixteenth Annual Report, 1903 | |
| Bulletin 214 | The Ribbed Cocoon Maker of the Apple | M. V. Slingerland and Philena B. Fletcher. |
| 1904. | | |
| Bulletin 215 | The Grape Leaf Hopper | M. V. Slingerland. |
| Bulletin 216 | Spraying Experiments: | |
| | Spraying for Wild Mustard | J. L. Stone. |
| | The Dust Spray | J. Craig. |
| Bulletin 217 | Spray Calendar | |
| Bulletin 218 | Onion Blight | H. H. Whetzel. |
| Bulletin 219 | Diseases of Ginseng | J. M. Van Hook. |
| Bulletin 220 | Skimmed Milk for Pigs | H. H. Wing. |
| Bulletin 221 | Alfalfa in New York | J. L. Stone. |
| Bulletin 222 | Record of an Attempt to Increase the Fat in Milk by Means of Liberal Feeding. | H. H. Wing and J. A. Foord. |
| Bulletin 223 | The Grape Berry Moth | M. V. Slingerland. |
| Bulletin 224 | Two Grape Pests | M. V. Slingerland and F. Johnson. |

### NORTH CAROLINA STATION.

| | | |
|---|---|---|
| 1903. | | |
| Bulletin 189 | Feeding Farm Horses and Mules | C. W. Burkett. |
| Annual Report | Twenty-sixth Annual Report, 1903 | |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### NORTH DAKOTA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 58 | Some Stock Poisoning Plants of North Dakota | L. Van Es and L. R. Waldron. |
| Annual Report | Fourteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 59 | Trees and Fruit in North Dakota | C. B. Waldron. |
| Bulletin 60 | Analysis of Formaldehyde Sold in North Dakota | E. F. Ladd. |
| Bulletin 61 | Scabies in Sheep and Cattle and Mange in Horses | L. Van Es. |

### OHIO STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 142 | Clover and Alfalfa Seeds | A. D. Selby and J. F. Hicks. |
| Bulletin 143 | Twenty-Second Annual Report, 1903 | |
| | Meteorological Summary 1902 | C. A. Patton. |
| | Press Bulletins. Index. | |
| Bulletin 144 | Experiments with Sulphur Sprays for the Fall Treatment of the San José Scale. | P. J. Parrott and J. S. Houser. |
| Bulletin 145 | Studies in Potato Rosette | A. D. Selby. |
| Bulletin 146 | Varieties of Strawberries and Raspberries | W. J. Green and C. W. Waid. |
| 1904. | | |
| Bulletin 147 | Calendar for Treatment of Plant Diseases and Insect Pests. | W. J. Green and A. D. Selby. |
| Bulletin 148 | Peach Diseases, III. Studies in the Prevention of Leaf Curl and Scab. | A. D. Selby. |
| Bulletin 149 | The Hardy Catalpa as a Farm Crop | W. J. Green. |
| Bulletin 150 | Ohio Soil Studies, I. Chemical and Mechanical Analyses of the Soils under Experiment. Types Represented. Discussion of Results. | A. D. Selby and J. W. Ames. |
| Bulletin 153 | Forcing Tomatoes | W. J. Green and C. W. Waid. |
| Bulletin 154 | Varieties of Strawberries | W. J. Green and F. H. Ballou. |
| Bulletin 155 | Silage *v.* Grain for Dairy Cows | C. G. Williams. |

### OKLAHOMA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 60 | Planting Trees for Posts, Fuel, and Wind-breaks | O. M. Morris. |
| 1904. | | |
| Bulletin 61 | Field Experiments | F. C. Burtis and L. A. Moorhouse. |
| Bulletin 62 | Disinfecting Power of Coal-tar Dips | L. L. Lewis and J. F. Nicholson. |
| Bulletin 63 | Tuberculosis in Hogs | L. L. Lewis. |
| Annual Report | Thirteenth Annual Report, 1904 | |

### OREGON STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 77 | A Continuation of Bulletin No. 74 on Onions; also Notes on Strawberries and Varieties of Vegetables. | G. Coote. |
| Annual Report | Fifteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 78 | Canning Cheese | E. F. Pernot. |
| Bulletin 79 | Plant Food and Use of Fertilizers | A. L. Knisely. |
| Bulletin 80 | Some Results in Swine Feeding | J. Withycombe. |
| Bulletin 81 | The Apple in Oregon | E. R. Lake. |
| Annual Report | Sixteenth Annual Report, 1904 | |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### PENNSYLVANIA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 64 | Methods of Steer Feeding | T. I. Mairs and A. K. Risser. |
| Bulletin 65 | Forage and Soiling Experiments, 1902 | G. C. Watson and T. I. Mairs. |
| 1904. | | |
| Bulletin 66 | Spraying Grapes for Black Rot in Erie County, Pa | G. C. Butz. |
| Bulletin 67 | Variety Tests of Wheat | G. C. Watson and A. K. Risser. |
| Bulletin 68 | Methods of Steer Feeding, II. Barn *v.* Shed | T. I. Mairs and A. K Risser. |

### PORTO RICO STATION.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report | Annual Report, 1903 | F. D. Gardner. |
| 1904. | | |
| Bulletin 4 | Propagation and Marketing of Oranges in Porto Rico | H. C. Henricksen. |
| Circular 5 | Coffee Planting in Porto Rico | J. W. Van Leenhoff. |

### RHODE ISLAND STATION.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 98 | Analyses of Feeding Stuffs | H. J. Wheeler et al. |
| Bulletin 99 | A Six-year Rotation of Crops | H. J. Wheeler and G. E. Adams. |
| Bulletin 100 | When to Spray. Formulas and Notes on Spraying | A. E. Stene. |
| Bulletin 101 | Analyses of Commercial Fertilizers | H. J. Wheeler, B. L. Hartwell, and J. W. Kellogg. |
| Bulletin 102 | Commercial Fertilizers | Do. |
| Annual Report | Seventeenth Annual Report, 1904 | |

### SOUTH CAROLINA STATION.

| | | |
|---|---|---|
| 1903. | | |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 83 | Results of Practical Experiments with Peach Borer | C. C. Newman. |
| Bulletin 84 | The One-Horse Farm | J. S. Newman. |
| Bulletin 85 | Commercial Fertilizers | M. B. Hardin. |
| Bulletin 86 | Tobacco Culture in South Carolina | T. B. Young. |
| Bulletin 87 | Analyses of Commercial Fertilizers, Season of 1903–4 | M. B. Hardin. |
| Bulletin 88 | Sorghum as a Sirup Plant | J. S. Newman et al. |
| Bulletin 89 | Sanitary Conditions in the Home and on the Farm | H. Metcalf. |
| Bulletin 90 | Texas Fever, II. Inoculation | G. E. Nesom. |
| Bulletin 91 | Coast Experiments. Report of Progress | |
| Bulletin 92 | Analyses of Commercial Fertilizers. Season 1903–4, Part II. | M. B. Hardin. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### SOUTH DAKOTA STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 82 | Macaroni Wheat: Its Milling and Chemical Characteristics. | J. H. Shepard. |
| 1904. | | |
| Bulletin 83 | Millet for Fattening Swine | J. W. Wilson and H. G. Skinner. |
| Bulletin 84 | Report of Investigations at the Highmore Station for 1903. | W. A. Wheeler. |
| Bulletin 85 | Early Garden Peas | N. E. Hansen. |
| Bulletin 86 | Fattening Range Lambs | J. W. Wilson and H. G. Skinner. |
| Bulletin 87 | The Western Sand Cherry | N. E. Hansen. |
| Bulletin 88 | Breeding Hardy Fruits | Do. |
| Annual Report | Annual Report, 1904 | |

### TENNESSEE STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bul. Vol. XVII, No. 1. | Crops for the Silo | A. M. Soule and J. R. Fain. |
| Bul. Vol. XVII, No. 2. | Increasing the Yield of Corn | A. M. Soule and P. O. Vanatter. |
| Bul. Vol. XVII, No. 3. | Training and Pruning Fruit Trees and Vines | C. A. Keffer. |
| Bul. Vol. XVII, No. 4. | Replacing Grain with Alfalfa in a Ration for Dairy Cows. | A. M. Soule and S. E. Barnes. |

### TEXAS STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Circular 4 | How to Combat the Mexican Cotton Boll Weevil in Summer and Fall. | E. D. Sanderson. |
| 1904. | | |
| Circular 5 | Cutworms | E. D. Sanderson. |
| Circular 6 | Two Plum Weevils | Do. |
| Circular 7 | Grasshoppers | Do. |
| Circular 8 | The Cotton Boll Weevil in Texas | Do. |
| Circular 9 | Directions for Mailing Insects | Do. |
| Bulletin 70 | The Composition of Texas Cotton-seed Meal | H. H. Harrington and G. S. Fraps. |
| Bulletin 71 | Irish Potatoes | E. C. Green. |
| Bulletin 73 | The Composition of Rice By-products | G. S. Fraps. |
| Bulletin 74 | Insects Mistaken for the Mexican Cotton Boll Weevil | E. D. Sanderson. |
| Bulletin 75 | Cotton Investigations | R. L. Bennett. |

### UTAH.

| Publication. | Title. | Author. |
|---|---|---|
| 1902. | | |
| Annual Report | Thirteenth Annual Report, 1902 | |
| 1903. | | |
| Bulletin 83 | Pruning of Tree and Bush Fruits | W. N. Hutt. |
| Bulletin 84 | The Grain Smuts | L. A. Merrill and B. F. Eliason. |
| Bulletin 85 | Pear Blight | W. N. Hutt. |
| Bulletin 86 | The Right Way to Irrigate | J. A. Widtsoe and W. W. McLaughlin. |
| Annual Report | Fourteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 87 | The Codling Moth | E. D. Ball. |
| Bulletin 88 | The Relation of Smelter Smoke to Utah Agriculture | J. A. Widtsoe. |
| Bulletin 89 | A New Centrifugal Soil Elutriator | P. A. Yoder. |
| Bulletin 90 | Feeding Beet Molasses and Pulp to Sheep and Steers | L. A. Merrill and R. W. Clark. |
| Circular 1 | Memoranda of Plans for Arid Farm Investigations | |
| Circular 2 | Memoranda of Plans of Irrigation Investigations | |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### VERMONT STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 102 | The Measurement of Saw Logs | A. L. Daniels. |
| Bulletin 103 | The Maple Sap Flow | C. H. Jones, A. W. Edson, and W. J. Morse. |
| Annual Report | Sixteenth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 104 | Commercial Feeding Stuffs | J. L. Hills, C. H. Jones, and F. M. Hollister. |
| Bulletin 105 | The Maple Sap Flow (Popular Edition of Bulletin 103) | J. L. Hills. |
| Bulletin 106 | Abstract of Sixteenth Annual Report, 1903 | Do. |
| Bulletin 107 | Commercial Fertilizers | J. L. Hills, C. H. Jones, and F. M. Hollister. |
| Bulletin 108 | Commercial Fertilizers | Do. |

### VIRGINIA STATION.

| | | |
|---|---|---|
| 1902. | | |
| Bulletin 143 | Orchard Studies, XVI. The Composition of Apples | W. B. Alwood and R. J. Davidson. |
| 1903. | | |
| Bulletin 148 | Hay Substitutes | D. O. Nourse. |
| Bulletin 149 | Cowpeas and Soy Beans | Do. |

### WASHINGTON STATION.

| | | |
|---|---|---|
| 1901. | | |
| Annual Report | Eleventh Annual Report, 1901 | |
| 1902. | | |
| Annual Report | Twelfth Annual Report, 1902 | |
| 1904. | | |
| Bulletin 60 | A Report on the Range Conditions of Central Washington. | J. S. Cotton. |
| Bulletin 61 | A Report on Irrigation Conditions in the Yakima Valley, Washington. | O. L. Waller. |
| Bulletin 62 | The Raspberry-cane Maggot | W. H. Lawrence. |
| Bulletin 63 | The Raspberry-root Borer or the Blackberry-crown Borer. | Do. |
| Bulletin 64 | The Apple Scab in Western Washington | Do. |
| Bulletin 65 | Three Common Insect Pests of Western Washington | Do. |
| Bulletin 66 | Blackspot Canker | Do. |

### WEST VIRGINIA STATION.

| | | |
|---|---|---|
| 1902. | | |
| Annual Report | Fifteenth Annual Report, 1902 | |
| 1903. | | |
| Circular 1 | Treatment of the San José Scale | J. H. Stewart. |
| Circular 2 | Muskmelon Blight | W. M. Morgan. |
| Circular 3 | The Striped Cucumber Beetle | Do. |
| Bulletin 88 | Poultry Experiments | J. H. Stewart and H. Atwood. |
| Bulletin 89 | Rural Water Supply | C. D. Howard. |
| Bulletin 90 | Sheep Feeding Experiments—Notes on Parasites | J. H. Stewart and H. Atwood. |
| Bulletin 91 | Commercial Fertilizers, Report 1903, Part I | J. H. Stewart and B. H. Hite. |
| Bulletin 92 | Commercial Fertilizers, Report 1903, Part II | Do. |

*Station publications received by the Office of Experiment Stations during 1904*—Continued.

### WISCONSIN STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 105 | The Improvement of Home Grounds | F. Cranefield. |
| Bulletin 106 | Licensed Commercial Feeding Stuffs, 1903 | F. W. Woll and G. A. Olson. |
| Bulletin 107 | Official Tests of Dairy Cows, 1902-3 | F. W. Woll. |
| Annual Report | Twentieth Annual Report, 1903 | |
| 1904. | | |
| Bulletin 108 | Trees and Shrubs for Shade and Ornament | F. Cranefield. |
| Bulletin 109 | Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1904. | F. W. Woll. |
| Bulletin 110 | Spraying Fruit Trees, with Notes on the Common Insects and Fungus Diseases Infesting Orchards. | E. P. Sandsten. |
| Bulletin 111 | Oat Smut and its Prevention | R. A. Moore. |
| Bulletin 112 | Alfalfa in Wisconsin | Do. |
| Bulletin 113 | Licensed Commercial Fertilizers and Feeding Stuffs, 1904. | F. W. Woll and G. A. Olson. |
| Bulletin 114 | A Lesson in Bovine Tuberculosis | H. L. Russell. |
| Bulletin 115 | The Quality of Cheese as Affected by Rape and Other Green Forage Plants Fed to Dairy Cows | U. S. Baer and W. L. Carlyle. |
| Annual Report | Twenty-first Annual Report, 1904 | |

### WYOMING STATION.

| Publication. | Title. | Author. |
|---|---|---|
| 1903. | | |
| Bulletin 59 | Wheat Grasses of Wyoming | A. and E. E. Nelson. |
| Bulletin 60 | Wheat Growing on the Laramie Plains | B. C. Buffum. |
| 1904. | | |
| Bulletin 61 | Seepage Investigations in the Valley of the Laramie River. | B. P. Fleming. |
| Bulletin 62 | Some Food Products and Their Adulteration | H. G. Knight and R. B. Moudy. |
| Bulletin 63 | Native and Introduced Saltbushes | E. Nelson. |

# STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1904.

Compiled by Miss M. T. Spethmann.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with a few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of July 2, 1862. These statistics have been compiled in part from replies to a circular of inquiry sent out from the Office of Experiment Stations, and in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, and August 30, 1890, prepared in the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

## SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1904 is estimated to be as follows: Land-grant fund of 1862, $11,765,406.13; other land-grant funds, $3,123,913.49; other permanent funds, $12,489,036.82; land-grant of 1862 still unsold, $4,310,249.48; farm and grounds owned by the institutions, $5,853,987.98; buildings, $24,972,905.97; apparatus, $2,021,418.93; machinery, $1,988,440.82; libraries, $2,347,347.95; live stock, $306,485.64; miscellaneous equipment, $3,361,394.90; total, $72,540,588.11. The income of these institutions in 1904, exclusive of the funds received from the United States for agricultural experiment stations ($719,999.67), was as follows: Interest on land grant of 1862, $730,001.58; interest on other land grants, $85,134.65; United States appropriation under act of 1890, $1,200,000; interest on endowment or regular appropriation, $1,074,-605.22; State appropriation for current expenses, $2,332,485.56; State appropriation for buildings or for other special purposes, $2,210,811.39; endowment, other than Federal or State grants, $680,123.23; tuition fees, $1,041,692.48; incidental fees, $395,424.27; miscellaneous, $1,748,062.97; total, $11,498,341.35. The value of the additions to the permanent endowment and equipment of these institutions in 1904 is estimated as follows: Permanent endowment, $638,600.10; buildings, $1,956,268.39; libraries, $142,768.38; apparatus, $139,465.95; machinery, $143,382.94; live stock, $67,509.04; miscellaneous, $133,978.73; total, $3,221,973.53.

The number of persons in the faculties of the colleges of agriculture and mechanic arts was as follows: For preparatory classes, 372; for collegiate and special classes, 2,160; total, 2,740. In the other departments the faculties aggregated 1,575, making a grand total of 4,315 persons in the faculties of the land-grant institutions. The students in 1904 were as follows: (1) By classes—preparatory, 10,019; collegiate classes, 21,237; short course or special, 6,157; postgraduate, 565; other departments, 18,783; total, 56,226. (2) By courses: *Four-year*—agriculture, 4,436; horticulture, 636; household economy, 3,607; mechanical engineering, 4,435; civil engineering, 3,353; electrical engineering, 2,708; mining engineering, 931; chemical engineering, 273; architecture, 227. *Shorter*—agriculture, 5,281; dairying, 735; horticulture, 112; veterinary science, 834; military tactics, 18,377. The graduates in 1904 were 4,822, and since the organization of these institutions 57,909. The average age of graduates in 1904 was 21 years and 10 months. The total number of volumes in the libraries was 1,927,045. The total number of acres of land granted to the States under the act of 1862 was 10,145,169, of which 897,142 are still unsold.

## SUMMARY OF STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, and Porto Rico.

In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the act of 1887 during 1904 was $1,508,820.25, of which $719,999.67 was received from the National Government, the remainder, $788,820.58, coming from the following sources: State governments, $522,391.89; individuals and communities, $7,300; fees for analyses of fertilizers, $94,070.82; sales from farm products, $110,359.43; miscellaneous, $54,698.44. In addition to this the Office of Experiment Stations had an appropriation of $175,000 for the past fiscal year, including $15,000 for the Alaska experiment stations, $15,000 for the Hawaii Experiment Station, $15,000 for the Porto Rico Experiment Station, $20,000 for nutrition investigations, $65,000 for irrigation investigations, and $5,000 for farmers' institutes. The value of additions to the equipment of the stations in 1904 is estimated as follows: Buildings, $168,087.44; libraries, $12,859.04; apparatus, $29,996.77; farm implements, $18,360.68; live stock, $34,065.94; miscellaneous, $30,081.82; total, $293,451.69.

The stations employ 795 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 54; assistant and vice-directors, 17; special agents in charge, 3; chemists, 163; agriculturists, 47; agronomists, 41; animal husbandmen, 46; poultrymen, 8; horticulturists, 76; farm and garden foremen, 30; dairymen, 35; botanists, 55; plant pathologists, 7; entomologists, 59; zoologists, 4; veterinarians, 29; meteorologists, 8; foresters, 4; mycologists, 3; biologists, 6; physicists, 6; geologists, 7; bacteriologists, 20; irrigation engineers, 11; in charge of substations, 28; secretaries and treasurers, 31; librarians, 13; clerks and stenographers, 42. There are also 63 persons classified under the head of "Miscellaneous," including superintendents of grounds and buildings, gardeners, plant breeders, farm mechanics, cheese experimenters, etc. Four hundred and fourteen station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 393 annual reports and bulletins, which were supplied to nearly 700,000 addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

## STATISTICS OF THE LAND-GRANT COLLEGES AND UNIVERSITIES.[a]

Unless otherwise specified, the statistics reported in the tables are for the institutions as designated in the list given below:

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study.*

[All of the institutions in this list, except those marked with an asterisk (*), maintain courses of instruction in agriculture.]

| State or Territory. | Name of institution. | Location. | President. | Collegiate courses of study (undergraduate). | |
|---|---|---|---|---|---|
| | | | | Four-year courses and degrees. | Short courses. |
| Alabama | Alabama Polytechnic Institute. | Auburn | C. C. Thach, M. A | Chem. and agr., civil engin., elect. and mech. engin., mining engin., phar., general, chem. and metal. (B. S.). | Agr., mech. arts, phar. (2 yrs.), agr. (1 yr.). |
| | Agricultural and Mechanical College for Negroes. | Normal | W. H. Councill, Ph. D. | Sci. (B. S.), agr. (B. A. S.), mech. (B. M. S.). | Indus. and lit. studies (1 to 4 yrs.). |
| Arizona | University of Arizona | Tucson | K. C. Babcock, Ph. D. | Lit. (Ph. B.), sci., engin., chem., mining, agr. (B. S.). | Mineralogy and assaying (2 yrs.). |
| Arkansas | University of Arkansas. | Fayetteville | H. S. Hartzog, LL. D. | Agr. (B. S. A.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), lit. and sci. (B. A. and B. S.). | Mech. engin., elect. engin., normal (2 yrs.). |
| | *Branch Normal College. | Pine Bluff | Isaac Fisher | Collegiate (B. A.) | Normal, dom. econ., typewriting. |
| California | University of California | Berkeley | B. I. Wheeler, Ph. D., LL. D. | Letters (B. A.), social sci. (B. L.), natural sci., commerce, agr., mech. mining, civil engin., chem. (B. S.). | Prep. med. (3 yrs.), agr. and hort., dairying (10 weeks), summer session (6 weeks). |
| Colorado | The State Agricultural College of Colorado. | Fort Collins | B. O. Aylesworth, M. A., LL. D., Litt. D. | Agr., mech. engin., civil and irrig. engin., elect. engin., domestic sci., archi., hort., vet. sci. (B. S.). | Commercial, normal, domestic sci. (2 yrs.). |
| Connecticut | Connecticut Agricultural College. | Storrs | R. W. Stimson, M. A., D. B. | Agr., hort., civil engin., home econ., general sci. (B. S.). | Agr., hort., mech., home econ., coml., general sci. (2 yrs., diploma), summer school for teachers (2 weeks), farm dairying, creamery, pomol., business (winter, 12 weeks), poultry (6 weeks), 33 ten-day courses. |
| Delaware | Delaware College | Newark | G. A. Harter, M. A., Ph. D. | Clas., Lat. sci. (B. A.), agr., general sci. (B. S.), civil engin. (B. C. E.), mech. engin. (B. M. E.), elect. engin. (B. E. E.). | Agr. (2 yrs.) agr. (winter, 10 weeks). |
| | State College for Colored Students. | Dover | W. C. Jason, M. A., B. D. | Clas. (B. A.), sci. (B. S.), agr. (B. Agr.), engin. (B. E.). | Normal (3 yrs.). |
| Florida | University of Florida | Lake City | Andrew Sledd, A. M., Ph. D. | Agr., mech. engin., chem., Lat. sci., civil engin., general sci. (B. S.), clas. (B. A.). | Mech. arts (2 yrs.), business, stenography, and typewriting (1 yr.). |
| | Florida State Normal and Industrial School. | Tallahassee | N. B. Young, M. A. | | Normal, academic, and industrial. |

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|---|---|---|---|---|---|
| Georgia.......... | Georgia State College of Agriculture and Mechanic Arts. | Athens......... | H. C. White, Ph. D... | General sci., agr., civil engin., elect. engin. (B. S.). | Agr., hort., dairying (1 yr.), agr. (12 weeks). |
| | Georgia State Industrial College. | College.......... | R. R. Wright, M. A., LL. D. | Collegiate.................................. | Normal, industrial, preparatory. |
| Idaho............ | University of Idaho.... | Moscow........ | J. A. MacLean, A. M., Ph. D. | Clas. (B. A.), agr., sci., hort. (B. S.), civil engin. (C. E.), mining engin. (B. M. E.), elect. engin. (E. E.), music (B. M.). | Agr. (2 yrs.), agr. and hort. (6 weeks). |
| Illinois.......... | University of Illinois... | Urbana......... | E. J. James, Ph. D., LL. D. | Lit. and arts (B. A.), engin., sci., agr. (B. S.), music (B. M.), libr. sci. (B. L. S.), phar. (Ph. G.), phar. chem. (Ph. C.), med. (M. D.). | Law (LL. B.), surgery (DD. S.) (3 yrs.). |
| Indiana.......... | Purdue University..... | Lafayette....... | W. E. Stone, Ph. D... | Mech. engin. (B. S., M. E.), civil engin. (B. S., C. E.), elect. engin. (B. S., E. E.), agr. (B. S. Agr.), sci. (B. S.), phar. (B. S. Phar.). | Agr. (2 yrs.), agr., hort., animal husb., dairying (winter, 10 weeks), phar. (2 yrs., Ph. G.). |
| Iowa............ | Iowa State College of Agriculture and the Mechanic Arts. | Ames........... | A. B. Storms, A. M., D. D., LL. D. | Agr. (B. S. A.), vet. sci. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. C. E.), elect. engin. (B. S., E. E.), mining engin. (B. S., M. E.), sci., general and domestic sci. for women (B. S.), tech. (B. S.). | Dairying (1 yr.), dairying (16 weeks), corn judging (2 weeks), stock judging (2 weeks). |
| Kansas.......... | Kansas State Agricultural College. | Manhattan..... | E. R. Nichols, M. A.. | Agr., mech. engin., general sci., elect. engin., domestic sci., archi. (B. S.). | Domestic sci. (2 fall terms, 12 weeks each), farmers' (2 winter terms, 12 weeks each), farm dairying (12 weeks), dairying (12 weeks). |
| Kentucky....... | Agricultural and Mechanical College of Kentucky. | Lexington...... | J. K. Patterson, Ph. D., LL. D. | Clas. (B. A.), mech. engin., (B. M. E.), civil engin. (B. C. E.), mining engin. (B. M. E.), agr. (B. Agr.), sci. (B. S.), pedag. (B. Ped.) | Agr. (2 yrs.), agr. (winter, 10 weeks). |
| | The Kentucky Normal and Industrial Institute for Colored Persons. | Frankfort...... | J. S. Hathaway, M. A., M. D. | Normal.................................. | Normal, agr., business, carpentry, cooking, music, dressmaking, printing, blacksmithing, wheelwrighting. |
| Louisiana....... | Louisiana State University and Agricultural and Mechanical College. | Baton Rouge... | T. D. Boyd, M. A., LL. D. | Agr., elect. engin., sugar engin., civil engin., mech., general sci. (B. S.), commercial, Lat. sci., lit. (B. A.). | Preparatory (1 yr.), agr. (2 yrs.). |
| | Southern University and Agricultural and Mechanical College. | New Orleans... | H. A. Hill............. | Clas., sci., agr., mech., normal, printing, music. | Agr., dairying, bookkeeping (2 yrs.), mech., tinsmithing (3 yrs.), typewriting. |
| Maine........... | The University of Maine. | Orono.......... | G. E. Fellows, M. A., Ph. D., LL. D. | Ten elective courses (B. A. or B. S.), nine technical courses (B. S.), law (LL. B.). | Agr. (2 yrs.), phar. (Ph. C.) (2 yrs.) agr., hort., and dairying (8 weeks), poultry management, hort. (3 weeks). |
| Maryland....... | Maryland Agricultural College. | College Park... | R. W. Silvester........ | Mech. engin. (B. M. E.), agr., sci. (B. S.).... | Agr. (2 yrs.), agr. (10 weeks). |
| | Princess Anne Academy. | Princess Anne.. | Frank Trigg, M. A.... | Academic.................................. | Industrial. |
| Massachusetts... | Massachusetts Agricultural College. | Amherst........ | H. H. Goodell, LL. D.. | Agr. (B. S.), postgraduate (M. S., Ph. D.).... | Agr. for women (2 yrs), dairying, hort. (winter, 10 weeks), bee culture (2 weeks). |

[a] Including also institutions receiving apportionments from the appropriation of 1890.

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

| State or Territory. | Name of institution. | Location. | President. | Collegiate courses of study (undergraduate). | |
|---|---|---|---|---|---|
| | | | | Four-year courses and degrees. | Short courses. |
| Massachusetts | *Massachusetts Institute of Technology. | Boston | H. S. Pritchett | Civil engin., mech. engin., mining engin. and metal., archi., chem., elect. engin., biol., phys., general studies, chem. engin., sanitary engin., geol., naval archi. (B. S.). | |
| Michigan | Michigan State Agricultural College. | Agricultural College. | J. L. Snyder, M. A., Ph. D. | Agr., mech., forestry, women's (B. S., each 4 and 5 years). | Cheesemaking (4 weeks), creamery management, live stock and general farming (8 weeks), fruit culture (8 weeks), beet-sugar production (20 weeks). |
| Minnesota | The University of Minnesota. | Minneapolis | Cyrus Northrop, LL. D. | General (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), mining, metal. (E. M., Met. E.), chem. (A. C. or C. T.), agr. (B. S.) | Agr. (3 yrs.), agr. (8 weeks), dairying (4 weeks). |
| Mississippi | Mississippi Agricultural and Mechanical College. | Agricultural College. | J. C. Hardy, M. A., LL.D. | Agr., hort., dairying, vet. sci., chem., mech. engin., phys. and elect. engin., civil and rural engin., geol. and mining, textile (B. S.). | Agr., mech. arts, elect. engin., textile (2 yrs.), agr. (10 weeks). |
| | Alcorn Agricultural and Mechanical College. | Westside | W. H. Lanier, B. A. | Scientific (B. S.) | Business, carpentry, agr., shoemaking, blacksmithing, painting, domestic sci., millinery, etc. |
| Missouri | University of Missouri | Columbia | R. H. Jesse, LL.D | Agr. (B. S.), civil engin. (B. S., C. E.), mech. engin., mining engin. (B. S., M. E.), elect. engin. (B. S., E. E.), sanitary engin., chem., metal., archi. (B. S.). | Plant production, animal husb., dairying (8 weeks), summer school for teachers (13 weeks). |
| | Lincoln Institute | Jefferson City | B. F. Allen, M. A., LL.D. | Collegiate (B. A.), normal | College prep. (3 yrs.), normal prep. (2 yrs.), carpentry, blacksmithing, mach. work (3 yrs.), sewing, cooking, laundering (3 yrs.). |
| Montana | The Montana State College of Agriculture and Mechanic Arts. | Bozeman | J. M. Hamilton | General sci., home sci. (B. S.), agr. (B. S. Agr.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), biol. (B. S.), art, music. | Agr., domestic sci., (3 yrs.), business (1 yr.), domestic sci. (1 yr.), agr. engin. (2 winter terms, 18 weeks each). |
| Nebraska | The University of Nebraska. | Lincoln | E. B. Andrews, LL.D. | Clas., lit. (B. A.), general sci., agr., civil engin., elect. engin., steam engin., municipal engin., mech. engin. (B. S.). | Agr. (3 yrs.), agr. (1 yr.) mech. arts, domestic sci. (2 yrs.), dairying, agr. (9 weeks), summer session (6 weeks), judging (1 week). |
| Nevada | Nevada State University. | Reno | J. E. Stubbs, M. A., D. D. | Liberal arts (B. A.), mining and metal., agr., domestic sci., mech. engin., civil engin., general sci. | Agr., dairying, bot., ent., bact., domestic sci., assaying (3 months). |
| New Hampshire. | The New Hampshire College of Agriculture and the Mechanic Arts. | Durham | W. D. Gibbs, M. S. | Agr., mech. engin., elect., tech., chem., general (B. S.). | Agr. (2 yrs.), agr. (winter, 10 weeks), dairying (10 weeks). |

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|---|---|---|---|---|---|
| New Jersey...... | Rutgers Scientific School, The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts. | New Brunswick | Austin Scott, Ph.D., LL.D. | Agr., civil engin. and mech., chem., elect., biol., clay working and ceramics (B. S.), Lat. sci. (B. Litt.). | |
| New Mexico..... | New Mexico College of Agriculture and Mechanic Arts. | Mesilla Park.... | Luther Foster, M. S. A. | Agr., mech. engin., domestic sci., general sci. (B. S.). | Agr. (2 yrs.), pract. mech. (2 yrs.) agr. and hort. (12 weeks). |
| New York ....... | Cornell University ..... | Ithaca .......... | J. G. Schurman, A. M., D. Sc., LL.D. | Arts (B. A.), law (LL. B.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr. (B. S. Agr.), med. (M. D.), vet. sci. (D. V. M.). | Agr. (1 or 2 years), agr., dairying and agr. (winter, 11 weeks). |
| North Carolina.. | The North Carolina College of Agriculture and Mechanic Arts. | Raleigh ........ | G. T. Winston, M. A., LL. D. | Agr., (B. A.), mech. engin., civil engin., elect. engin., mining engin., textile sci. and art. (B. E.), indus. chem. (B. S.). | Agr., mech. arts, textile indus. (2 yrs.), agr., dairying (10 weeks), normal (1 and 2 yrs.), summer school for teachers (1 month). |
| | The Agricultural and Mechanical College for the Colored Race. | Greensboro..... | J. B. Dudley, M. A ... | Agr., mech. (B. S., B. Agr.) ................ | Dairying (6 weeks). |
| North Dakota ... | North Dakota Agricultural College. | Agricultural College. | J. H. Worst, LL. D.... | Agr., sci., mech. (B. S.) ..................... | Agr. (3 yrs.), steam engin., dairying, phar., domestic econ., nature study (2 yrs.), agr. (10 weeks), stock and grain judging (10 days). |
| Ohio............. | Ohio State University .. | Columbus ...... | W. O. Thompson, D. D., LL. D. | Agr. (B. S. Agr.), hort. and forestry, domestic sci., chem., indus. arts, manual training, phar. (B. S.), arts (B. A.), archi., civil engin. (C. E.), clay working and ceramics, mining engin. (E. M.), elect. engin. (M. E., E. E.), mech. engin. (M. E.), vet. med. (D. V. M.), law (LL. B.). | Agr., ceramics, domestic econ., indus. arts, mining, phar. (2 yrs.), dairying (2 terms), vet. med. (3 yrs., D. V. M.). |
| Oklahoma ....... | Oklahoma Agricultural and Mechanical College. | Stillwater ...... | A. C. Scott, M. A., LL. M. | Agr., general sci., mech. engin. (5 yrs., B. S.). | Agr., domestic sci. (2 yrs.), business (1 yr.), agr., hort., mech. arts (winter, 8 weeks). |
| | Agricultural and Normal University. | Langston ....... | I. E. Page, M. A ...... | Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil archi. (B. M. E.). | Normal elementary (4 yrs.), college prep. (3 yrs.). |
| Oregon .......... | Oregon State Agricultural College. | Corvallis ....... | T. M. Gatch, M. A., Ph. D. | Agr., mech. engin., elect. engin., mining engin., household sci., phar., lit., commerce (B. S.). | Mining (2 yrs.), dairying (8 weeks), agr. (10 days). |
| Pennsylvania ... | The Pennsylvania State College. | State College ... | G. W. Atherton, LL. D. | Clas. (B. A.), general sci., mod. lang. and lit., Lat. sci., philos., agr., biol., chem., civil engin., elect. engin., indus. chem., math., mech. engin., mines and mining, phys. (B. S.). | Chem., mech., mining (2 yrs.), agr. (1 yr.), agr., mining (12 weeks), creamery (8 weeks). |
| Rhode Island.... | Rhode Island College of Agriculture and Mechanic Arts. | Kingston ....... | K. L. Butterfield, A. M. | Agr., mech. engin., highway engin., chem., biol., elect. engin., general sci. (B. S.). | Agr. (2 yrs.), indus. (2 yrs.), farm mech. (12 weeks), poultry school (6 weeks), farm practice (6 weeks). |
| South Carolina .. | Clemson Agricultural College of South Carolina. | Clemson College | P. H. Mell, M. E., Ph. D. | Agr., animal husb., mech. and elect. engin., civil engin., metal., textile engin. (B.S.). | Textile indus. (2 yrs.) |

TABLE 1.—*Institutions established under the land-grant act of July 2, 1862, and their courses of study*—Continued.

| State or Territory. | Name of institution. | Location. | President. | Collegiate courses of study (undergraduate). | |
|---|---|---|---|---|---|
| | | | | Four-year courses and degrees. | Short courses. |
| South Caralina | The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina. | Orangeburg | T. E. Miller, LL. D | Regular (B. A.), mech. (B. S.), agr. (B. Agr.), normal (L. I.). | |
| South Dakota | South Dakota Agricultural College. | Brookings | James Chalmers, Ph. D. | Agr., domestic sci., mech. engin., elect. engin., hort., phar. (B. S.). | Phar. (2 yrs., Ph. G.), agr. (6 weeks), hort., domestic sci., butter making, cheese making (12 weeks), sten. and typewriting, commercial sci., steam engin. (1 yr.), art (3 yrs.), music. |
| Tennessee | University of Tennessee | Knoxville | Brown Ayres, Ph. D., LL. D. | Lit. (B. A.), agr. sci., civil engin., mech. engin., elect. engin., mining engin., chem., phar. chem. (B. S.). | Agr., phar. (2 yrs.), agr., hort. (10 weeks), cereal judging, pract. stock feeding, stock judging and dairying, farm poultry (winter, 1 and 2 weeks), summer school for teachers (6 weeks). |
| Texas | Agricultural and Mechanical College of Texas. | College Station | D. F. Houston, M. A., LL. D. | Agr., textile engin., elect. engin., mech. engin., civil engin. (B. S.). | Stock farming, dairying, hort. (10 weeks). |
| | Prairieview State Normal and Industrial College. | Prairieview | E. L. Blackshear | Clas. and sci. (6 yrs., B. A.), normal, industrial. | |
| Utah | Agricultural College of Utah. | Logan | W. J. Kerr, D. Sc | Agr., domestic sci., commercial, civil engin., mech. engin., elect. engin., general sci. (B. S.), mech. arts. | Agr., domestic sci., commercial (4 yrs.), prep. (2 yrs.), prep. (1 yr.), agr. (4 weeks), domestic arts, mech. arts (12 weeks) |
| Vermont | University of Vermont and State Agricultural College. | Burlington | M. H. Buckham, D. D., LL. D | Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin., mech. engin., chem., agr. (B. S.), commerce and econ. | Agr. (1 or 2 yrs.). |
| Virginia | The Virginia Agricultural and Mechanical College and Polytechnic Institute. | Blacksburg | J. M. McBryde, Ph. D., LL. D. | Agr., hort., applied chem., general sci., civil engin., mech. engin., elect. engin., (B. S.), prep. med., applied geol. | Agr., mech. (2 yrs.). |
| | Hampton Normal and Agricultural Institute. | Hampton | H. B. Frissell, D. D., LL. D. | ........................ | Academic (4 yrs.), trade (3 yrs.). Post-graduate: Agr., trades (3 yrs.), normal (2 yrs.), business (1 yr.). |
| Washington | Washington Agricultural College and School of Science. | Pullman | E. A. Bryan, M. A., LL. D. | Math., civil engin., chem., bot. and zool., agr., hort., econ. sci. and hist., elect. engin., mech. engin., mining engin. (B. S., B. A.), geol., Engl. lang. and lit., modern lang. (B. A.). | Supplementary courses in phys., geol., and mineralogy, Lat., schools of phar. (2 yrs.), agr., vet. sci., prep. (3 yrs.), business (1 and 2 yrs.), artisans (1 yr.), dairying (8 weeks), hort. (4 weeks). |
| West Virginia | West Virginia University. | Morgantown | D. B. Purinton, Ph. D., LL. D. | General culture (B. A., B. S.), mech. engin. (B. S., M. E.), civil engin. (B. S., C. E.), steam engin., hydraulic engin., elect. engin. (B. S., M. E.), agr. (B. S. Agr.), law (LL. B.). | Agr. (B. Agr.), mech. and elect., law, commercial (2 yrs.), agr. (1 yr.), agr., hort., vet. sci., stock breeding and feeding, dairying, poultry culture (12 weeks), agr. (6 weeks). |

| | | | | | |
|---|---|---|---|---|---|
| | The West Virginia Colored Institute. | Institute........ | J. McH. Jones, A. M... | Academic, normal, agr., mech., printing... | Sewing (2 yrs.), dressmaking (3 yrs.). |
| Wisconsin....... | University of Wisconsin. | Madison........ | C. R. Van Hise, Ph. D.. | Sci. (B. A.), normal (B. Ph.), law (LL. B.), agr. (B. S. Agr.), civil engin., sanitary engin., mech. engin., general engin., applied electro-chem., pharm. (B. S.). | Music, agr. (2 winter courses, 14 weeks each), dairy school (12 weeks), creamery (summer). |
| Wyoming........ | University of Wyoming. | Laramie........ | F. M. Tisdel, Ph. D.... | Clas., lit. sci. (B. A.), normal (B. Ped.), agr., mech. engin., mining engin. (B. S.). | Commercial (2 yrs.), agr. (1 to 2 yrs.), normal (1 yr.), school of mines (6 weeks), animal husb. (winter), domestic sci. |

TABLE 2.—*General statistics of*

| State or Territory. | Date of establishment of institution. | Date of establishment of agricultural course. | Faculty. | | | | Experiment station officers. |
|---|---|---|---|---|---|---|---|
| | | | College of agriculture and mechanic arts. | | | Other departments. | |
| | | | Preparatory classes. | Collegiate and special classes. | Total. | | |
| Alabama (Auburn) | 1872 | 1872 | 4 | 30 | [a]31 | 3 | 14 |
| Alabama (Normal) | 1875 | 1882 | 13 | 7 | 20 | 30 | |
| Arizona | 1891 | 1891 | 17 | 15 | [a]29 | | 6 |
| Arkansas (Fayetteville) | 1872 | 1872 | 10 | 10 | [a]19 | 92 | 6 |
| Arkansas (Pine Bluff) | 1875 | | 5 | 4 | 9 | | |
| California | 1868 | 1868 | | 56 | 56 | 153 | 37 |
| Colorado | 1877 | 1878 | 15 | 28 | [a]41 | | 15 |
| Connecticut | 1881 | 1881 | | 24 | 24 | | 15 |
| Delaware (Newark) | 1870 | 1870 | | 19 | 19 | | 6 |
| Delaware (Dover) | 1892 | 1892 | 3 | 6 | [a]7 | | |
| Florida (Lake City) | 1884 | 1884 | 9 | 19 | [a]22 | 6 | 14 |
| Florida (Tallahassee) | 1887 | 1890 | 18 | | 18 | 2 | |
| Georgia (Athens) | 1872 | 1872 | | 24 | 24 | | |
| Georgia (College) | 1890 | 1890 | 10 | 4 | 14 | | |
| Idaho | 1892 | 1892 | 6 | 17 | 23 | 4 | 10 |
| Illinois | 1867 | 1868 | 10 | 164 | 174 | 175 | 33 |
| Indiana | 1874 | 1874 | | 90 | 90 | 13 | 10 |
| Iowa | 1869 | 1869 | | 101 | 101 | | 35 |
| Kansas | 1863 | 1874 | 4 | 62 | 66 | 14 | 18 |
| Kentucky (Lexington) | 1865 | 1880 | 5 | 25 | 30 | 12 | 14 |
| Kentucky (Frankfort) | 1887 | 1892 | 2 | 8 | 10 | 5 | |
| Louisiana (Baton Rouge) | 1877 | 1887 | 1 | 22 | 23 | 3 | 25 |
| Louisiana (New Orleans) | 1880 | 1890 | 9 | 8 | 17 | | |
| Maine | 1865 | 1868 | 4 | 45 | [a]45 | 13 | 12 |
| Maryland (College Park) | 1859 | 1859 | 2 | 18 | 20 | | 15 |
| Maryland (Princess Anne) | | | 2 | 9 | 11 | | |
| Massachusetts (Amherst) | 1867 | 1867 | | 28 | 28 | | 21 |
| Massachusetts (Boston) | 1865 | | | 186 | 186 | | |
| Michigan | 1855 | 1855 | | | 70 | | 11 |
| Minnesota | 1869 | 1869 | | [c]96 | [a]94 | 213 | 15 |
| Mississippi (Agricultural College) | 1880 | 1880 | 6 | 28 | 34 | 15 | 12 |
| Mississippi (Westside) | 1871 | 1878 | 13 | 6 | 19 | | |
| Missouri (Columbia) | 1870 | 1870 | | 62 | 62 | 65 | 21 |
| Missouri (Jefferson City) | 1866 | 1866 | 9 | 12 | 21 | | |
| Montana | 1893 | 1893 | 16 | 22 | [a]30 | | 11 |
| Nebraska | 1869 | 1869 | | 78 | 78 | 173 | 17 |
| Nevada | 1873 | 1888 | 4 | 20 | 24 | | 9 |
| New Hampshire | 1866 | 1866 | | 21 | 21 | | 12 |
| New Jersey | 1864 | 1865 | 11 | 30 | [a]40 | 3 | 21 |
| New Mexico | 1889 | 1890 | 4 | 24 | 28 | | 12 |
| New York | 1865 | 1865 | | | 31 | 374 | 19 |
| North Carolina (Raleigh) | 1889 | 1889 | | 34 | 39 | | 14 |
| North Carolina (Greensboro) | 1891 | 1891 | 12 | 12 | [a]12 | | |
| North Dakota | 1890 | 1890 | 12 | 25 | [a]33 | | 15 |
| Ohio | 1870 | 1873 | | 105 | 105 | 35 | |
| Oklahoma (Stillwater) | 1891 | 1892 | | 28 | 28 | | 11 |
| Oklahoma (Langston) | 1897 | 1899 | 12 | | 12 | | |
| Oregon | 1868 | 1888 | | 33 | 33 | | 11 |
| Pennsylvania | 1855 | 1859 | 8 | 59 | [a]59 | | 20 |
| Rhode Island | 1888 | 1890 | 6 | 24 | [a]24 | | 11 |
| South Carolina (Clemson College) | 1889 | 1893 | 6 | 41 | [a]43 | 43 | 17 |
| South Carolina (Orangeburg) | 1896 | 1896 | 12 | 6 | 18 | 8 | |
| South Dakota | 1881 | 1884 | 4 | 35 | 39 | | 17 |
| Tennessee | 1794 | 1869 | | 47 | 47 | 45 | 9 |
| Texas (College Station) | 1871 | 1871 | | 36 | 36 | | 12 |
| Texas (Prairie View) | | | 6 | | 11 | 7 | |
| Utah | 1888 | 1889 | | | 50 | | 15 |
| Vermont | 1865 | 1885 | | 38 | 38 | 33 | 12 |
| Virginia (Blacksburg) | 1872 | 1872 | | 56 | 56 | | 18 |
| Virginia (Hampton) | 1865 | 1890 | | | 135 | | |
| Washington | 1892 | 1892 | 6 | 45 | 51 | | 12 |
| West Virginia (Morgantown) | 1867 | 1867 | 7 | 38 | 45 | 19 | 15 |
| West Virginia (Institute) | 1891 | 1892 | 6 | 11 | 17 | 17 | |
| Wisconsin | 1848 | 1866 | 41 | 35 | 76 | | 23 |
| Wyoming | 1887 | 1891 | 22 | 24 | [a]24 | | 9 |
| Total | | | 372 | 2,160 | 2,740 | 1,575 | 707 |

[a] Total, counting none twice.

[b] Including all departments of the university.

*land-grant colleges in 1904.*

| Graduates. | | | | Number of volumes in library. | Number of acres allotted to State under act of 1862. | Number of acres of land grant of 1862 still unsold. | Number of acres in farm and grounds. | Rate of interest on land-grant fund of 1862. |
|---|---|---|---|---|---|---|---|---|
| In 1903-4. | | | Total number since organization. | | | | | |
| Number. | Average age. | | | | | | | |
| | *Y.* | *M.* | | | | | | *Per cent.* |
| 52 | 20 | 10 | 779 | 20,135 | 240,000 | .............. | 325 | 8 |
| 126 | 19 | 0 | 872 | 5,235 | .............. | .............. | 182 | ............ |
| 5 | 22 | 6 | 40 | 20,900 | .............. | .............. | 465 | ............ |
| 30 | 23 | 0 | 356 | 9,000 | 150,000 | .............. | 155 | 8 |
| 7 | 19 | 0 | 167 | 7,000 | .............. | .............. | 20 | ............ |
| 365 | 23 | 6 | b3,684 | 108,418 | 150,000 | 4,074 | 411 | 6 |
| 22 | 21 | 0 | 255 | 22,185 | 90,000 | 44,685 | 600 | 6 |
| 8 | 21 | 1 | 220 | 11,000 | 180,000 | .............. | 300 | 5 |
| 20 | 22 | 6 | 341 | 23,000 | 90,000 | .............. | 16 | 6 |
| 2 | 25 | 0 | 24 | 900 | .............. | .............. | 97 | ............ |
| 8 | 20 | 8 | 91 | 4,500 | 90,000 | .............. | 333 | 6 |
| 11 | 23 | 0 | 60 | 1,600 | .............. | .............. | 160 | ............ |
| 13 | 21 | 0 | 399 | 38,000 | 270,000 | .............. | 113 | 7 |
| 20 | 21 | 0 | 145 | 700 | .............. | .............. | 86 | ............ |
| 14 | 22 | 4 | 112 | 7,200 | 90,000 | 90,000 | 156 | ............ |
| 598 | 23 | 6 | b3,994 | 103,936 | 480,000 | 40 | 665 | 5 |
| 219 | 23 | 1 | 1,981 | 15,800 | 390,000 | .............. | 189 | 5 |
| 120 | 24 | 0 | ............ | 21,000 | 204,000 | 496 | 841 | 6, 7, 8 |
| 99 | 23 | 6 | 1,017 | 28,732 | 82,313 | .............. | 430 | 5, 5½, 6, 7 |
| 74 | 21 | 0 | 410 | 17,764 | 330,000 | .............. | 258 | 6 |
| 9 | 20 | 0 | 124 | 2,650 | .............. | .............. | 310 | ............ |
| 22 | 21 | 3 | 342 | 38,000 | 210,000 | .............. | 583 | 4, 5 |
| 52 | 18 | 7 | 297 | 3,993 | .............. | .............. | 104 | ............ |
| 78 | 23 | 4 | 893 | 34,000 | 210,000 | .............. | 373 | 5 |
| 13 | 20 | 0 | ............ | 7,000 | 210,000 | .............. | 286 | 5, 6 |
| 8 | 20 | 0 | 17 | .............. | .............. | .............. | 116 | ............ |
| 21 | 23 | 6 | 632 | 25,268 | 360,000 | .............. | 404 | 5 |
| 231 | 23 | 4 | 3,123 | 82,110 | .............. | .............. | 16 | ............ |
| 55 | ............ | | 1,026 | 22,868 | 240,000 | 53,330 | 671 | 7 |
| 454 | ............ | | b4,967 | 142,000 | 94,000 | 40 | 300 | 3, 4, 5 |
| 31 | 20 | 1 | 357 | 19,778 | 207,920 | .............. | 2,000 | 6 |
| 8 | 25 | 0 | 148 | 2,700 | .............. | .............. | 300 | 5 |
| 116 | 22 | 0 | 2,368 | 30,000 | 277,016 | 47,107 | 722 | 5 |
| 104 | ............ | | 324 | 1,010 | .............. | .............. | 40 | ............ |
| 8 | 21 | 0 | 43 | 15,000 | 90,000 | 90,000 | 220 | ............ |
| 156 | 22 | 0 | b2,201 | 65,000 | 90,000 | 30,000 | 332 | 4½, 6 |
| 18 | 22 | 0 | 238 | 10,200 | 90,000 | 2,288 | 85 | 4 |
| 14 | 24 | 0 | 266 | 16,082 | 150,000 | .............. | 343 | 6 |
| 44 | 22 | 4 | 533 | 51,859 | 210,000 | .............. | 105 | 5 |
| 6 | 27 | 0 | 47 | 18,071 | .............. | .............. | 270 | ............ |
| 532 | ............ | | b7,562 | 332,905 | 989,920 | .............. | 498 | 5 |
| ............ | ............ | | 211 | 6,600 | 270,000 | .............. | 643 | 6 |
| 6 | 21 | 0 | 41 | 11,023 | .............. | .............. | 125 | ............ |
| 6 | ............ | | 39 | 9,500 | 130,000 | 97,970 | 640 | ............ |
| 196 | 22 | 0 | 1,732 | 53,223 | 630,000 | .............. | 345 | 6 |
| 20 | 21 | 6 | 96 | 27,479 | .............. | .............. | 360 | ............ |
| 4 | 22 | 0 | 6 | 1,100 | .............. | .............. | 160 | ............ |
| 35 | 20 | 0 | 501 | 3,600 | 90,000 | .............. | 204 | 6 |
| 71 | 23 | 3 | 725 | 21,323 | 780,000 | .............. | 400 | 6 |
| 3 | 22 | 0 | 104 | 16,800 | 120,000 | .............. | 178 | 3 |
| 38 | 22 | 0 | 296 | 13,643 | .............. | .............. | 1,136 | 6 |
| 51 | 20 | 0 | 284 | 1,390 | .............. | .............. | 130 | ............ |
| 21 | 22 | 0 | 253 | 17,726 | 160,000 | 159,628 | 400 | ............ |
| 32 | 23 | 2 | ............ | 27,500 | 300,000 | .............. | 272 | 6 |
| 36 | 19 | 0 | 495 | 16,300 | 180,000 | .............. | 2,416 | 6, 7 |
| 46 | 21 | 0 | 352 | 1,196 | .............. | .............. | 1,500 | ............ |
| 14 | 22 | 3 | 112 | 12,500 | 200,000 | 97,132 | 116 | ............ |
| 95 | 23 | 0 | 3,776 | 100,952 | 150,000 | .............. | 120 | 6 |
| 71 | 21 | 0 | 506 | 6,500 | 200,000 | .............. | 410 | 6 |
| 61 | 22 | 9 | 1,297 | 13,409 | 100,000 | .............. | 798 | ............ |
| 61 | 19 | 0 | 186 | 12,500 | 90,000 | 90,000 | 250 | ............ |
| 51 | 24 | 0 | 932 | 20,750 | 150,000 | .............. | 130 | 6 |
| 11 | 19 | 0 | 114 | 2,400 | .............. | .............. | 70 | ............ |
| 91 | 21 | 0 | b5,280 | 116,000 | 240,000 | 352 | 460 | 4 |
| 14 | 22 | 0 | 116 | 26,132 | 90,000 | 90,000 | 416 | ............ |
| 4,822 | 21 | 10 | 57,909 | 1,927,045 | 10,145,169 | 897,142 | 25,559 | ............ |

c Including preparatory classes.

TABLE 3.—*Students by classes and*

| State or Territory. | By classes. | | | | | |
|---|---|---|---|---|---|---|
| | Preparatory classes. | Collegiate classes. | Short or special. | Postgraduate. | Other departments. | Total. |
| Alabama (Auburn) | 55 | 339 | 71 | 15 | | 480 |
| Alabama (Normal) | 211 | 180 | | 90 | | 481 |
| Arizona | 129 | 71 | | 5 | | 205 |
| Arkansas (Fayetteville) | 413 | 353 | 45 | 3 | 438 | 1,252 |
| Arkansas (Pine Bluff) | 110 | 89 | | 1 | | 200 |
| California | | 911 | 30 | 62 | 2,303 | 3,306 |
| Colorado | 215 | 199 | 8 | 11 | | 433 |
| Connecticut | | 108 | 75 | | | [c] 180 |
| Delaware (Newark) | | 118 | 4 | 3 | | 125 |
| Delaware (Dover) | 43 | 27 | 8 | | | 78 |
| Florida (Lake City) | 115 | 70 | 6 | 2 | | [c] 176 |
| Florida (Tallahassee) | 229 | | | | | 229 |
| Georgia (Athens) | | 149 | 10 | 4 | | 163 |
| Georgia (College) | 409 | 25 | | | | 434 |
| Idaho | 204 | 134 | 22 | | 60 | 420 |
| Illinois | 257 | 1,782 | 377 | 118 | 1,184 | [c] 3,594 |
| Indiana | | 1,386 | 20 | 34 | | 1,440 |
| Iowa | 298 | 1,097 | 551 | 22 | 17 | 1,985 |
| Kansas | 443 | 884 | 294 | 20 | | [c] 1,605 |
| Kentucky (Lexington) | 133 | 418 | 4 | 14 | 107 | 676 |
| Kentucky (Frankfort) | 87 | 64 | | | 22 | 173 |
| Louisiana (Baton Rouge) | 114 | 313 | 9 | 2 | | 438 |
| Louisiana (New Orleans) | 418 | | 350 | | | [c] 418 |
| Maine | 6 | 420 | 37 | 11 | 71 | [c] 543 |
| Maryland (College Park) | 30 | 119 | 35 | 5 | | 189 |
| Maryland (Princess Anne) | 59 | 121 | | | | 180 |
| Massachusetts (Amherst) | | 181 | 32 | 7 | | 220 |
| Massachusetts (Boston) | | 1,510 | | 18 | | 1,528 |
| Michigan | 184 | 561 | 174 | 4 | | 923 |
| Minnesota | 522 | 563 | 153 | 3 | 2,584 | 3,825 |
| Mississippi (Agricultural College) | 272 | 385 | 42 | 10 | | 709 |
| Mississippi (Westside) | 643 | 86 | | | | 729 |
| Missouri (Columbia) | | 54 | 92 | 1 | 1,308 | 1,455 |
| Missouri (Jefferson City) | 70 | | | | 332 | 402 |
| Montana | 92 | 67 | 48 | 1 | 149 | 357 |
| Nebraska | 301 | 453 | | | 1,759 | 2,513 |
| Nevada | 68 | 138 | 42 | | | 248 |
| New Hampshire | | 106 | 28 | | | 134 |
| New Jersey | 153 | 162 | | 5 | 58 | 378 |
| New Mexico | 124 | 32 | 67 | 1 | | 224 |
| New York | | 1,037 | 69 | | 1,985 | 3,091 |
| North Carolina (Raleigh) | | 439 | 411 | 8 | | 858 |
| North Carolina (Greensboro) | 126 | 23 | | | | 149 |
| North Dakota | 140 | 59 | 520 | 1 | | 720 |
| Ohio | | 875 | 122 | 2 | 804 | 1,803 |
| Oklahoma (Stillwater) | | 189 | 230 | 1 | | [c] 417 |
| Oklahoma (Langston) | 271 | | | | | 271 |
| Oregon | 85 | 442 | | 3 | | 530 |
| Pennsylvania | 40 | 618 | 66 | 6 | [e] 2,100 | 2,830 |
| Rhode Island | 62 | 49 | 30 | 1 | | 142 |
| South Carolina (Clemson College) | 146 | 459 | | 5 | | 610 |
| South Carolina (Orangeburg) | 658 | 53 | | | | 711 |
| South Dakota | 157 | 151 | 200 | 11 | | 519 |
| Tennessee | | 294 | 53 | 5 | 353 | 705 |
| Texas (College Station) | | 354 | 22 | 2 | | 378 |
| Texas (Prairieview) | 312 | | | | | 312 |
| Utah | 106 | 111 | 379 | | 27 | 623 |
| Vermont | | 341 | | 7 | 225 | 573 |
| Virginia (Blacksburg) | | 650 | 56 | 21 | | 727 |
| Virginia (Hampton) | 913 | 314 | [g] 527 | 8 | | 1,762 |
| Washington | 388 | 208 | 50 | 7 | | 653 |
| West Virginia (Morgantown) | | 72 | 45 | 2 | 872 | 991 |
| West Virginia (Institute) | 194 | 3 | | | | 197 |
| Wisconsin | | 801 | 652 | 3 | 1,870 | 3,326 |
| Wyoming | 14 | 20 | 91 | | 155 | 280 |
| Total | 10,019 | 21,237 | 6,157 | 565 | 18,783 | 56,226 |

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[a] Including horticulture.
[b] Including electrical engineering.
[c] Total, counting none twice.
[d] Including horticulture and dairying.

*courses at land-grant colleges in 1904.*

| By courses. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Four-year. | | | | | | | | | Shorter. | | | | |
| Agriculture. | Horticulture. | Household economy. | Mechanical engineering. | Civil engineering. | Electrical engineering. | Mining engineering. | Chemical engineering. | Architecture. | Agriculture. | Dairying. | Horticulture. | Veterinary science. | Military tactics. |
| 25 | 18 | .... | 64 | 47 | 61 | 12 | .... | .... | 8 | .... | .... | 10 | 431 |
| 117 | .... | 200 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 230 |
| .... | .... | .... | .... | .... | .... | 18 | .... | .... | .... | .... | .... | .... | 102 |
| 25 | 25 | .... | 40 | 65 | 58 | 2 | 1 | .... | .... | .... | .... | .... | 640 |
| .... | .... | 96 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| a 55 | .... | .... | b 217 | 148 | .... | 248 | 107 | .... | 49 | 23 | 7 | .... | 880 |
| 21 | .... | 30 | 27 | 42 | 15 | .... | .... | 5 | .... | .... | .... | 10 | 312 |
| 53 | .... | 7 | .... | .... | .... | .... | .... | .... | 1 | 6 | 1 | 2 | 78 |
| 3 | 3 | .... | 7 | 40 | 31 | .... | .... | .... | 4 | .... | .... | .... | 92 |
| 20 | .... | 36 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 35 | 7 | .... | 42 | 30 | .... | .... | .... | .... | .... | .... | .... | .... | 171 |
| 18 | .... | 132 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 11 | 11 | .... | .... | 28 | 4 | .... | .... | 6 | 10 | 10 | 10 | .... | 163 |
| .... | .... | 95 | .... | .... | .... | .... | .... | .... | 115 | .... | .... | .... | 280 |
| 2 | 1 | .... | .... | 11 | 15 | 34 | .... | .... | d 22 | .... | .... | .... | 166 |
| a 160 | .... | 28 | 221 | 275 | 179 | .... | .... | 102 | d 134 | .... | .... | 114 | 916 |
| 46 | .... | .... | 364 | 300 | 413 | .... | .... | .... | 82 | 62 | .... | 97 | 748 |
| 338 | 19 | 105 | 174 | 232 | 235 | 39 | .... | .... | 551 | 61 | .... | 52 | 400 |
| 198 | .... | 243 | 107 | .... | 170 | .... | .... | .... | 122 | 16 | .... | .... | 450 |
| 17 | .... | .... | 177 | 70 | .... | 6 | .... | .... | 4 | .... | .... | .... | 552 |
| .... | .... | 90 | .... | .... | .... | .... | .... | .... | 20 | .... | .... | .... | 70 |
| a 49 | .... | .... | 35 | 57 | 16 | .... | 45 | .... | 1 | .... | .... | 51 | 346 |
| 41 | .... | 180 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 10 | .... | .... | 51 | 135 | 109 | 5 | .... | .... | 24 | .... | .... | .... | 211 |
| 8 | 8 | .... | 58 | .... | .... | .... | 1 | .... | 17 | 3 | 17 | 24 | 175 |
| 32 | .... | 103 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 60 |
| 181 | 76 | .... | .... | 56 | .... | .... | .... | .... | 27 | 27 | 27 | 12 | 193 |
| .... | .... | .... | 161 | 132 | 126 | 91 | 27 | 53 | .... | .... | .... | .... | 263 |
| 148 | .... | 94 | 236 | .... | .... | .... | .... | .... | 86 | 60 | 9 | .... | 714 |
| 30 | 30 | 2 | 87 | 101 | 150 | 118 | 31 | .... | 47 | 106 | .... | .... | 900 |
| 272 | 240 | .... | 55 | 8 | 24 | .... | 19 | .... | .... | 1 | .... | 47 | 675 |
| 382 | .... | 205 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 125 | 75 | .... | 44 | 110 | 108 | 162 | 3 | .... | a 19 | 32 | .... | 12 | 202 |
| .... | .... | 205 | .... | .... | .... | .... | .... | .... | 70 | .... | .... | .... | .... |
| .... | .... | 4 | 12 | 8 | 5 | .... | .... | .... | 8 | 6 | .... | .... | 65 |
| 12 | 17 | .... | 58 | 103 | 87 | .... | .... | .... | 258 | .... | .... | .... | 405 |
| 1 | .... | .... | 21 | 6 | .... | 44 | .... | .... | .... | .... | .... | .... | 130 |
| 16 | .... | .... | 12 | .... | 17 | .... | .... | .... | 18 | 6 | .... | .... | 94 |
| 12 | .... | .... | .... | 65 | 35 | .... | 20 | .... | .... | .... | .... | .... | 153 |
| 7 | .... | 6 | 9 | .... | .... | .... | .... | .... | 1 | .... | .... | .... | 140 |
| 77 | .... | .... | 960 | 325 | .... | .... | .... | 52 | 65 | .... | .... | 86 | 400 |
| 50 | .... | .... | 73 | 66 | 71 | 1 | 19 | .... | 65 | 25 | .... | .... | 517 |
| 137 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 7 | 3 | 10 | 8 | .... | .... | .... | .... | .... | 200 | .... | .... | 93 | 70 |
| 80 | 21 | 26 | 86 | 94 | 106 | 38 | .... | 9 | 67 | 31 | .... | 91 | 975 |
| a 18 | .... | .... | b 33 | .... | .... | .... | .... | .... | 139 | .... | .... | .... | .... |
| 20 | .... | 137 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 59 | .... | 60 | 88 | .... | 18 | 24 | .... | .... | 10 | .... | .... | .... | 354 |
| 15 | .... | .... | 119 | 147 | 187 | 63 | .... | .... | 2,125 | 36 | .... | .... | 500 |
| .... | .... | .... | .... | .... | .... | .... | .... | .... | 29 | .... | .... | .... | 65 |
| 223 | 9 | .... | b 323 | 12 | .... | .... | .... | .... | .... | .... | .... | .... | 602 |
| 30 | .... | 313 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 241 |
| 15 | 3 | 25 | 30 | .... | 25 | .... | .... | .... | 20 | 8 | .... | 8 | 150 |
| 16 | f 45 | 25 | 25 | 94 | 8 | .... | .... | .... | 25 | 25 | 25 | 25 | 163 |
| 99 | .... | .... | 42 | 94 | .... | .... | .... | .... | 22 | .... | .... | 80 | 358 |
| .... | .... | 169 | .... | .... | .... | .... | .... | .... | 73 | .... | .... | .... | .... |
| 9 | .... | 14 | 6 | 19 | .... | .... | .... | .... | 47 | .... | .... | .... | 218 |
| 43 | .... | .... | 18 | 46 | 43 | .... | .... | .... | .... | .... | .... | .... | 200 |
| 40 | 24 | .... | 161 | 148 | 215 | .... | .... | .... | 7 | .... | .... | 13 | 706 |
| 956 | .... | 850 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 468 |
| 9 | 1 | 13 | 23 | 29 | 6 | 17 | .... | .... | 93 | 16 | 16 | 7 | .... |
| 3 | .... | .... | 60 | 62 | .... | .... | .... | .... | 20 | .... | .... | .... | 225 |
| .... | .... | 104 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 87 |
| a 57 | .... | .... | 93 | 148 | 171 | .... | .... | .... | a 485 | 175 | .... | .... | 500 |
| 3 | .... | .... | 8 | .... | .... | 9 | .... | .... | 91 | .... | .... | .... | 171 |
| 4,436 | 636 | 3,607 | 4,435 | 3,353 | 2,708 | 931 | 273 | 227 | 5,281 | 735 | 112 | 834 | 18,377 |

e Including correspondence courses.
f Including forestry.
g Summer institute.

TABLE 4.—*Value of permanent funds and*

| State or Territory. | Land-grant fund of 1862. | Other land-grant funds. | Other permanent funds. | Land grant of 1862 still unsold. | Farm and grounds owned by the institution. |
|---|---|---|---|---|---|
| Alabama (Auburn) | $253,500.00 | | | | $4,500.00 |
| Alabama (Normal) | | | | | 18,200.00 |
| Arizona | | | | | 25,640.00 |
| Arkansas (Fayetteville) | 130,000.00 | | | | 12,000.00 |
| Arkansas (Pine Bluff) | | | | | 50,000.00 |
| California | 732,083.30 | $79,750.00 | $2,390,080.49 | $8,000.00 | 215,000.00 |
| Colorado | 95,328.83 | | | 150,000.00 | 99,000.00 |
| Connecticut | 135,000.00 | | | | 15,000.00 |
| Delaware (Newark) | 83,000.00 | | | | 10,000.00 |
| Delaware (Dover) | | | | | 6,000.00 |
| Florida (Lake City) | 154,300.00 | | | | 18,800.00 |
| Florida (Tallahassee) | | | | | 8,000.00 |
| Georgia (Athens) | 242,202.47 | | | | 5,500.00 |
| Georgia (College) | | | | | 10,000.00 |
| Idaho | | 130,307.11 | | 900,000.00 | 18,000.00 |
| Illinois | 618,221.53 | | | 400.00 | 150,000.00 |
| Indiana | 340,000.00 | | | | 100,000.00 |
| Iowa | 589,754.01 | 93,954.51 | | 2,304.08 | 82,463.00 |
| Kansas | 492,381.36 | | | | 50,200.00 |
| Kentucky (Lexington) | 165,000.00 | | | | 408,266.00 |
| Kentucky (Frankfort) | | | | | 25,000.00 |
| Louisiana (Baton Rouge) | 182,313.00 | 136,000.00 | | | 35,000.00 |
| Louisiana (New Orleans) | | | | | 22,500.00 |
| Maine | 118,300.00 | | 100,000.00 | | 25,000.00 |
| Maryland (College Park) | 118,000.00 | | | | 28,600.00 |
| Maryland (Princess Anne) | | | | | 8,000.00 |
| Massachusetts (Amherst) | 219,000.00 | | 150,117.35 | | 44,350.00 |
| Massachusetts (Boston) | | | | | |
| Michigan | 956,179.68 | | | 93,387.40 | 46,970.00 |
| Minnesota | 570,749.59 | 767,246.15 | 37,004.26 | 320.00 | 550,000.00 |
| Mississippi (Agricultural College) | 98,575.00 | 141,212.55 | | | 43,500.00 |
| Mississippi (Westside) | 113,575.00 | 96,296.00 | | | 6,000.00 |
| Missouri (Columbia) | 349,881.19 | 220,000.00 | 663,958.23 | 60,000.00 | 265,206.00 |
| Missouri (Jefferson City) | | | | | 7,000.00 |
| Montana | 12,500.00 | 5,000.00 | | 180,000.00 | 25,000.00 |
| Nebraska | 318,207.00 | 121,207.00 | | | 325,000.00 |
| Nevada | 99,351.54 | 47,541.52 | | | 40,000.00 |
| New Hampshire | 80,000.00 | | 70,000.00 | | 20,500.00 |
| New Jersey | 116,000.00 | | 500,000.00 | | 130,000.00 |
| New Mexico | | | | | 9,000.00 |
| New York | 688,576.12 | | 6,960,276.49 | | 369,077.98 |
| North Carolina (Raleigh) | 125,000.00 | | | | 37,000.00 |
| North Carolina (Greensboro) | | | | | 20,000.00 |
| North Dakota | 350,797.62 | | | 979,700.00 | 32,000.00 |
| Ohio | 524,176.58 | 53,070.19 | | | 1,500,000.00 |
| Oklahoma (Stillwater) | | | | | 15,000.00 |
| Oklahoma (Langston) | | | | | 6,000.00 |
| Oregon | 169,452.09 | | | | 31,000.00 |
| Pennsylvania | 427,290.50 | | | | 40,000.00 |
| Rhode Island | 50,000.00 | | | | 14,855.00 |
| South Carolina (Clemson College) | 95,900.00 | | | | 42,470.00 |
| South Carolina (Orangeburg) | 95,900.00 | | | | 40,000.00 |
| South Dakota | 4,585.07 | | | 800,000.00 | 40,000.00 |
| Tennessee | 400,000.00 | | | | 116,370.00 |
| Texas (College Station) | 209,000.00 | | | | 48,320.00 |
| Texas (Prairieview ) | | | | | 15,000.00 |
| Utah | 150,376.80 | | | 145,698.00 | 12,800.00 |
| Vermont | 135,500.00 | | 421,000.00 | | 12,000.00 |
| Virginia (Blacksburg) | 344,312.00 | | | | 31,000.00 |
| Virginia (Hampton) | 172,156.00 | | 1,195,000.00 | | 57,000.00 |
| Washington | | 1,000,000.00 | | 900,000.00 | 20,000.00 |
| West Virginia (Morgantown) | 114,169.67 | | 1,600.00 | | 225,000.00 |
| West Virginia (Institute) | | | | | 10,400.00 |
| Wisconsin | 303,359.61 | 228,263.75 | | 440.00 | 143,500.00 |
| Wyoming | 21,450.57 | 4,064.71 | | 90,000.00 | 12,000.00 |
| Total | 11,765,406.13 | 3,123,913.49 | 12,489,036.82 | 4,310,249.48 | 5,853,987.98 |

[a] Including all other equipment.

*equipment of land-grant colleges, 1904.*

| Buildings. | Apparatus. | Machinery. | Library. | Live stock. | Miscellaneous equipment. | Total. |
|---|---|---|---|---|---|---|
| $143,000.00 | $15,200.00 | $22,000.00 | $35,900.00 | $3,500.00 | $17,300.00 | $494,900.00 |
| 45,500.00 | 5,000.00 | 5,592.30 | 4,000.00 | 326.00 | 782.09 | 79,400.39 |
| 146,908.89 | 22,032.01 | 15,332.17 | 16,514.69 | 1,300.00 | .............. | 227,727.76 |
| 300,000.00 | 55,000.00 | 28,000.00 | 7,600.00 | 1,250.00 | .............. | 533,850.00 |
| 26,000.00 | 500.00 | 12,000.00 | 3,000.00 | .............. | 1,500.00 | 93,000.00 |
| 1,792,998.25 | .............. | .............. | .............. | .............. | .............. | 5,217,912.04 |
| 178,849.00 | 49,000.00 | 17,000.00 | 21,604.75 | 8,425.00 | 18,000.00 | 637,207.58 |
| 122,000.00 | 10,600.00 | 7,100.00 | 21,000.00 | 8,800.00 | 18,000.00 | 337,500.00 |
| 130,000.00 | 50,000.00 | 20,000.00 | 21,000.00 | 250.00 | 8,000.00 | 322,250.00 |
| 18,800.00 | 1,000.00 | 800.00 | .............. | .............. | .............. | 26,600.00 |
| 121,200.00 | .............. | .............. | .............. | .............. | [a] 68,827.89 | 363,127.89 |
| 23,700.00 | 2,340.00 | 1,200.00 | 400.00 | 1,000.00 | 1,009.00 | 37,649.00 |
| 263,553.36 | 24,276.69 | .............. | 20,000.00 | 1,200.00 | .............. | 556,732.52 |
| 32,433.04 | 3,144.00 | .............. | 100.00 | 415.00 | .............. | 46,092.04 |
| 188,129.00 | 22,425.01 | 6,914.34 | 12,963.16 | 4,413.11 | 13,950.00 | 1,297,101.73 |
| 1,300,000.00 | 175,000.00 | 75,000.00 | 110,000.00 | 20,000.00 | 120,000.00 | 2,568,621.53 |
| 555,900.00 | .............. | [b] 163,850.00 | 18,600.00 | 4,400.00 | 20,000.00 | 1,202,750.00 |
| 638,812.50 | 76,904.21 | 50,000.00 | 30,500.00 | 22,386.00 | 200,000.00 | 1,787,078.31 |
| 381,375.00 | 42,745.00 | 17,300.00 | 46,400.00 | 9,865.00 | 135,179.00 | 1,175,445.36 |
| 245,052.00 | 48,626.00 | 25,596.00 | 12,247.00 | 2,754.00 | 420,307.00 | 1,327,848.00 |
| 38,000.00 | 250.00 | 2,600.00 | 1,800.00 | 1,785.00 | 1,200.00 | 70,635.00 |
| 302,000.00 | 20,439.31 | 19,100.43 | 27,695.40 | .............. | 26,000.00 | 748,548.14 |
| 47,760.82 | 3,644.31 | 4,415.10 | 3,980.00 | 1,100.00 | 7,551.10 | 90,951.33 |
| 260,000.00 | 24,278.00 | 16,640.00 | 30,000.00 | 4,700.00 | 13,000.00 | 591,918.00 |
| 140,000.00 | .............. | .............. | .............. | .............. | [a] 37,500.00 | 324,100.00 |
| 14,279.00 | [c] 1,189.00 | .............. | .............. | 1,000.00 | 500.00 | 24,968.00 |
| 248,775.00 | 10,000.00 | .............. | 25,973.00 | 9,881.00 | 138,389.35 | 846,485.70 |
| 876,839.82 | .............. | [b] 360,000.00 | 136,302.00 | .............. | .............. | 1,373,141.82 |
| 402,220.00 | 78,985.16 | 29,168.93 | 45,564.40 | 12,365.50 | 42,751.78 | 1,707,592.85 |
| 1,250,000.00 | 119,000.00 | 82,450.00 | 100,000.00 | .............. | .............. | 3,476,770.00 |
| 270,551.55 | 24,009.51 | 97,986.56 | 18,376.36 | 15,883.00 | 67,971.12 | 778,065.65 |
| 160,000.00 | 10,000.00 | .............. | 3,000.00 | 2,000.00 | 2,000.00 | 392,871.00 |
| 960,000.00 | 119,512.72 | 13,517.26 | 116,710.67 | 7,214.95 | 63,959.78 | 2,839,960.80 |
| 110,000.00 | 600.00 | 5,000.00 | 1,300.00 | 300.00 | 500.00 | 124,700.00 |
| 100,000.00 | 27,000.00 | 30,000.00 | 15,000.00 | 1,000.00 | 18,000.00 | 413,500.00 |
| 509,000.00 | [c] 100,000.00 | .............. | 135,000.00 | 12,000.00 | 116,000.00 | 1,636,414.00 |
| 167,023.46 | 19,667.28 | 12,672.66 | 19,245.59 | 1,337.95 | 39,595.46 | 446,435.46 |
| 207,000.00 | 22,000.00 | 6,300.00 | 13,000.00 | 3,700.00 | 15,000.00 | 437,500.00 |
| 400,000.00 | .............. | .............. | 46,000.00 | .............. | 75,000.00 | 1,267,000.00 |
| 53,000.00 | 18,000.00 | 20,250.00 | 14,500.00 | 1,300.00 | 7,000.00 | 123,050.00 |
| 2,911,007.83 | .............. | .............. | 565,903.00 | .............. | 878,546.53 | 12,373,387.95 |
| 156,917.00 | 15,000.00 | 37,000.00 | 6,500.00 | 5,000.00 | 15,000.00 | 397,417.00 |
| 44,900.00 | 21,874.13 | .............. | 1,500.00 | 3,200.00 | .............. | 91,474.13 |
| 155,000.00 | 13,919.65 | 10,803.53 | 17,033.85 | 5,898.22 | 850.00 | 1,566,002.87 |
| 1,000,000.00 | 300,000.00 | 100,000.00 | 170,000.00 | 7,000.00 | 15,000.00 | 3,669,246.77 |
| 98,500.00 | 36,749.01 | 23,508.12 | 20,079.47 | 11,509.00 | .............. | 205,345.60 |
| 35,000.85 | 1,700.00 | 9,569.25 | 1,900.00 | 600.00 | 2,244.25 | 57,013.85 |
| 160,000.00 | 4,000.00 | 20,000.00 | .............. | .............. | .............. | 384,452.09 |
| 1,114,705.00 | .............. | .............. | .............. | .............. | [a] 60,000.00 | 1,641,995.50 |
| 151,367.50 | 38,930.52 | .............. | 16,386.69 | 1,470.56 | 56,913.77 | 329,924.04 |
| 406,394.10 | 161,603.54 | 68,668.00 | 10,057.00 | 9,649.00 | .............. | 794,741.64 |
| 85,000.00 | 3,600.00 | 7,150.00 | 1,700.00 | 2,200.00 | 2,000.00 | 237,550.00 |
| 195,000.00 | 13,000.00 | 12,000.00 | 5,300.00 | 10,000.00 | 25,600.00 | 1,104,885.07 |
| 207,086.92 | 50,956.27 | 47,669.35 | 12,646.94 | 4,031.00 | 14,215.53 | 852,976.01 |
| 500,000.00 | .............. | 20,301.24 | 13,000.00 | 12,035.00 | [b] 26,809.87 | 829,466.11 |
| 93,600.00 | 2,000.00 | 3,000.00 | 1,100.00 | 2,760.00 | .............. | 117,460.00 |
| 242,427.28 | 13,042.70 | 16,479.45 | 9,534.79 | 6,081.55 | 33,216.64 | 629,657.21 |
| 710,000.00 | 42,000.00 | 21,000.00 | 100,000.00 | 3,620.00 | 165,500.00 | 1,610,620.00 |
| 257,400.00 | .............. | .............. | 3,200.00 | .............. | [a] 126,475.87 | 762,387.87 |
| 600,000.00 | .............. | .............. | 7,000.00 | 14,000.00 | 159,000.00 | 2,204,156.00 |
| 260,000.00 | 24,000.00 | 44,800.00 | 22,000.00 | 6,000.00 | 17,000.00 | 2,293,800.00 |
| 460,000.00 | 11,000.00 | 20,000.00 | 40,000.00 | 1,500.00 | 40,000.00 | 913,269.67 |
| 81,500.00 | 2,325.00 | 11,500.00 | 3,300.00 | 1,175.00 | .............. | 110,200.00 |
| 1,693,439.30 | .............. | [b] 317,117.50 | 157,927.00 | 30,858.00 | .............. | 2,874,905.16 |
| 183,000.00 | 63,319.90 | 30,088.63 | 26,002.19 | 2,046.80 | 8,848.87 | 440,851.67 |
| 24,972,905.97 | 2,021,418.93 | 1,988,440.82 | 2,347,347.95 | 306,485.64 | 3,361,394.90 | 72,540,588.11 |

[b] Including apparatus.

[c] Including machinery.

TABLE 5.—*Revenue of land-grant*

| State or Territory. | Federal aid. | | | State aid. |
|---|---|---|---|---|
| | Interest on land grant of 1862. | Interest on other land grants. | Appropriation act of 1890. | Interest on endowment or regular appropriation. |
| Alabama (Auburn) | $20,280.00 | | $13,850.00 | |
| Alabama (Normal) | | | 11,150.00 | $4,000.00 |
| Arizona | | | 25,000.00 | |
| Arkansas (Fayetteville) | 10,157.43 | | 18,181.82 | |
| Arkansas (Pine Bluff) | | | 6,818.18 | |
| California | 43,925.00 | $4,785.00 | 25,000.00 | 401,446.06 |
| Colorado | 9,968.12 | | 25,000.00 | |
| Connecticut | 4,900.00 | | 25,000.00 | |
| Delaware (Newark) | 4,980.00 | | 20,000.00 | |
| Delaware (Dover) | | | 5,000.00 | |
| Florida (Lake City) | 7,747.76 | | 12,500.00 | |
| Florida (Tallahassee) | | | 12,500.00 | |
| Georgia (Athens) | 16,954.14 | | 16,666.66 | |
| Georgia (College) | | | 8,333.34 | 8,000.00 |
| Idaho | | 6,460.08 | 25,000.00 | |
| Illinois | 34,223.37 | | 25,000.00 | |
| Indiana | 17,000.00 | | 25,000.00 | |
| Iowa | 41,176.83 | | 25,000.00 | |
| Kansas | 25,687.70 | | 25,000.00 | |
| Kentucky (Lexington) | 8,644.50 | | 21,375.00 | 36,830.32 |
| Kentucky (Frankfort) | 1,255.50 | | 3,625.00 | |
| Louisiana (Baton Rouge) | 9,115.69 | 5,440.00 | 12,651.23 | |
| Louisiana (New Orleans) | | | 12,348.77 | |
| Maine | 5,915.00 | | 25,000.00 | |
| Maryland (College Park) | 5,900.00 | | 20,000.00 | |
| Maryland (Princess Anne) | | | 5,000.00 | |
| Massachusetts (Amherst) | 3,650.00 | | 16,666.66 | 1,919.19 |
| Massachusetts (Boston) | 5,223.94 | | 8,333.34 | |
| Michigan | 67,312.37 | | 25,000.00 | 100,000.00 |
| Minnesota | 22,928.77 | | 25,000.00 | 30,823.78 |
| Mississippi (Agricultural College) | 5,914.00 | 8,472.75 | 11,562.50 | |
| Mississippi (Westside) | 6,814.50 | 5,777.77 | 13,437.50 | |
| Missouri (Columbia) | 21,997.61 | 7,320.00 | 23,437.50 | 44,822.38 |
| Missouri (Jefferson City) | | | 1,562.50 | |
| Montana | 8,988.00 | | 25,000.00 | |
| Nebraska | 35,000.00 | 20,000.00 | 25,000.00 | 95,000.00 |
| Nevada | 4,109.90 | 1,932.87 | 25,000.00 | |
| New Hampshire | 4,800.00 | | 25,000.00 | |
| New Jersey | 5,800.00 | | 25,000.00 | |
| New Mexico | | | 25,000.00 | |
| New York | 34,428.80 | | 25,000.00 | |
| North Carolina (Raleigh) | 7,500.00 | | 16,750.00 | |
| North Carolina (Greensboro) | | | 8,250.00 | |
| North Dakota | 22,948.32 | | 25,000.00 | |
| Ohio | 31,450.59 | 2,806.78 | 25,000.00 | 341,380.92 |
| Oklahoma (Stillwater) | | 8,902.84 | 22,500.00 | |
| Oklahoma (Langston) | | | 2,500.00 | |
| Oregon | 10,943.36 | | 25,000.00 | |
| Pennsylvania | 25,637.43 | | 25,000.00 | 5,382.57 |
| Rhode Island | 2,500.00 | | 25,000.00 | |
| South Carolina (Clemson College) | 5,754.00 | | 12,500.00 | |
| South Carolina (Orangeburg) | 5,754.00 | | 12,500.00 | |
| South Dakota | 13,027.06 | | 25,000.00 | |
| Tennessee | 23,960.00 | | 25,000.00 | |
| Texas (College Station) | 14,280.00 | | 18,750.00 | |
| Texas (Prairieview) | | | 6,250.00 | |
| Utah | 6,362.11 | | 25,000.00 | |
| Vermont | 8,130.00 | | 25,000.00 | 5,000.00 |
| Virginia (Blacksburg) | 20,658.72 | | 16,666.67 | |
| Virginia (Hampton) | 10,329.36 | | 8,333.33 | |
| Washington | | | 25,000.00 | |
| West Virginia (Morgantown) | 6,553.00 | | 20,000.00 | |
| West Virginia (Institute) | | | 5,000.00 | |
| Wisconsin | 13,965.76 | 13,236.56 | 25,000.00 | |
| Wyoming | 5,448.94 | | 25,000.00 | |
| Total | 730,001.58 | 85,134.65 | 1,200,000.00 | 1,074,605.22 |

[a] Including tuition and incidental fees.
[b] Including incidental fees.

*colleges for year ended June 30, 1904.*

| State aid. | | Income from endowment other than Federal or State grants. | Fees and all other sources. | | | Total. | United States appropriation for experiment stations (act of 1887). |
|---|---|---|---|---|---|---|---|
| Appropriation for current expenses. | Appropriations for buildings or for other special purposes. | | Tuition fees. | Incidental fees. | Miscellaneous. | | |
| $24,321.43 | $1,500.00 | ... | $910.00 | $2,222.50 | $3,940.68 | $67,024.61 | $15,000.00 |
| ... | ... | ... | ... | 1,500.00 | 910.00 | 17,560.00 | ... |
| 21,998.68 | 34,400.00 | ... | ... | 3,445.21 | ... | 84,843.89 | 15,000.00 |
| 58,582.63 | 17,763.68 | ... | ... | 4,070.00 | 1,001.82 | 109,757.38 | 14,999.67 |
| 5,025.00 | ... | ... | ... | ... | 435.00 | 12,278.18 | ... |
| ... | 166,300.00 | $130,374.96 | 3,310.00 | 44,966.40 | 110,811.77 | 930,919.19 | 15,000.00 |
| 75,410.21 | ... | ... | ... | 1,101.00 | 7,825.68 | 119,305.01 | 15,000.00 |
| 20,425.00 | 1,800.00 | ... | ... | ... | 30,426.77 | 82,551.77 | 7,500.00 |
| ... | 7,500.00 | ... | 1,250.00 | 4,558.93 | 460.99 | 38,744.92 | 15,000.00 |
| ... | 2,000.00 | ... | ... | ... | 2,800.00 | 9,800.00 | ... |
| 45,863.02 | ... | ... | ... | ... | [a]2,408.62 | 68,519.40 | 15,000.00 |
| 1,000.00 | ... | ... | ... | ... | ... | 13,500.00 | ... |
| ... | ... | ... | ... | 744.50 | 588.73 | 34,954.03 | 15,000.00 |
| ... | ... | ... | ... | ... | ... | 16,333.34 | ... |
| 21,500.00 | ... | ... | ... | ... | 844.15 | 53,804.23 | 15,000.00 |
| 250,000.00 | 376,200.00 | ... | [b]199,755.04 | ... | 55,987.62 | 941,166.03 | 15,000.00 |
| 70,363.80 | 77,337.84 | ... | 6,150.00 | 37,123.05 | 10,943.41 | 243,918.10 | 15,000.00 |
| 80,000.00 | 141,080.01 | ... | 2,292.00 | 15,526.25 | 29,331.47 | 334,406.56 | 15,000.00 |
| 40,000.00 | 112,202.12 | ... | ... | 10,467.00 | ... | 213,356.82 | 15,000.00 |
| ... | ... | ... | 4,192.50 | 41.55 | ... | 71,083.87 | 15,000.00 |
| 8,000.00 | ... | ... | ... | 170.00 | 5,392.69 | 18,443.19 | ... |
| 15,000.00 | 10,825.54 | ... | ... | 2,187.50 | 7,322.81 | 62,542.77 | 15,000.00 |
| 10,000.00 | ... | ... | ... | ... | 767.99 | 23,116.76 | ... |
| 20,000.00 | 35,000.00 | 4,000.00 | 15,500.00 | 13,259.20 | ... | 118,674.20 | 15,000.00 |
| 9,000.00 | 52,000.00 | ... | 19,441.20 | 8,815.00 | 1,029.51 | 116,185.71 | ... |
| ... | ... | ... | 511.75 | 854.93 | 475.43 | 6,842.11 | ... |
| 21,000.00 | ... | 344.19 | 86.65 | 968.38 | 2,236.97 | 46,872.04 | 15,000.00 |
| 25,000.00 | ... | 65,000.00 | 286,660.55 | 16,080.40 | 30,510.22 | 436,808.45 | ... |
| ... | ... | ... | 660.00 | 5,424.00 | 40,503.15 | 238,899.52 | 15,000.00 |
| 187,029.68 | 132,500.00 | ... | 125,048.50 | ... | [b]27,820.88 | 551,151.61 | 15,000.00 |
| 65,946.36 | [c]75,512.50 | ... | 550.00 | 1,685.80 | 41,138.26 | 210,782.17 | 15,000.00 |
| 8,000.00 | 5,000.00 | ... | ... | 5,654.00 | 1,000.00 | 45,683.77 | ... |
| 174,078.62 | 156,468.33 | ... | ... | 14,894.01 | 28,005.72 | 471,024.17 | 15,000.00 |
| 22,175.00 | ... | ... | ... | ... | ... | 23,737.50 | ... |
| 15,000.00 | 13,000.00 | ... | 3,208.00 | ... | 4,189.54 | 69,385.54 | 15,000.00 |
| 40,000.00 | 147,250.00 | ... | 11,660.00 | 8,010.00 | 21,000.00 | 402,920.00 | 15,000.00 |
| 15,207.23 | ... | ... | 1,500.00 | ... | 718.04 | 48,468.04 | 15,000.00 |
| 10,500.00 | 7,000.00 | 3,584.93 | 1,358.00 | 1,129.21 | 15,460.81 | 68,832.95 | 15,000.00 |
| 2,500.00 | ... | 17,347.23 | ... | [d]6,262.30 | 699.09 | 57,608.62 | 15,000.00 |
| 13,456.66 | ... | ... | 1,339.00 | ... | 2,077.61 | 41,873.27 | 15,000.00 |
| ... | ... | 379,200.33 | 251,030.71 | 57,311.32 | 699,864.72 | 1,446,835.88 | 13,500.00 |
| 10,000.00 | 10,000.00 | ... | 11,489.47 | 5,595.84 | 12,252.21 | 73,587.52 | 15,000.00 |
| 7,500.00 | ... | ... | ... | ... | 8,529.61 | 24,279.61 | ... |
| 29,178.82 | ... | ... | ... | 586.60 | 5,968.70 | 83,682.44 | 15,000.00 |
| ... | 12,117.83 | ... | 6,210.00 | 49,514.21 | 113,880.25 | 582,360.58 | ... |
| 16,711.50 | 2,566.23 | ... | ... | 1,378.40 | 4,832.01 | 56,890.98 | 15,000.00 |
| 17,317.98 | ... | ... | ... | ... | ... | 19,817.98 | ... |
| 6,159.05 | 18,956.14 | ... | ... | 793.90 | 2,294.19 | 64,146.64 | 15,000.00 |
| 52,000.25 | 73,402.52 | ... | 350.00 | 10,735.65 | 44,683.70 | 237,192.12 | 15,000.00 |
| 15,000.00 | 7,000.00 | ... | 150.00 | 995.76 | 1,400.00 | 52,045.76 | 15,000.00 |
| 127,437.44 | ... | 3,512.36 | 3,250.00 | ... | 7,247.40 | 159,701.20 | 15,000.00 |
| ... | 5,000.00 | ... | ... | ... | ... | 23,254.00 | 15,000.00 |
| 31,500.00 | 44,500.00 | ... | 2,944.00 | 2,671.17 | 6,762.81 | 126,405.04 | 15,000.00 |
| ... | ... | 2,419.65 | [b]12,994.24 | ... | 24,505.93 | 88,879.82 | 15,000.00 |
| 60,000.00 | 130,000.00 | ... | ... | ... | ... | 223,030.00 | 15,000.00 |
| 20,500.00 | ... | ... | ... | ... | 11,000.00 | 37,750.00 | ... |
| 32,650.00 | 34,081.53 | ... | 2,816.00 | 1,031.80 | 9,000.24 | 110,941.68 | 15,000.00 |
| 6,000.00 | ... | 17,872.30 | [b]15,657.94 | ... | 4,002.82 | 81,663.06 | 15,000.00 |
| 29,999.99 | 82,500.00 | ... | [b]25,800.70 | ... | 970.57 | 176,596.65 | 15,000.00 |
| ... | ... | 55,151.62 | ... | ... | 110,420.88 | 184,235.19 | ... |
| 55,000.00 | 12,500.00 | ... | 140.00 | 2,878.00 | 14,838.00 | 110,356.00 | 15,000.00 |
| 90,049.94 | 35,278.01 | ... | ... | ... | 62,131.06 | 214,012.01 | 15,000.00 |
| 11,600.00 | 10,000.00 | ... | ... | 168.00 | 1,732.00 | 28,500.00 | ... |
| 327,000.00 | 144,500.00 | 1,315.66 | 22,878.23 | 50,520.50 | 110,511.87 | 708,928.58 | 15,000.00 |
| 10,497.27 | 15,769.11 | ... | 598.00 | 87.00 | 2,168.57 | 59,568.89 | 15,000.00 |
| 2,332,485.56 | 2,210,811.39 | 680,123.23 | 1,041,692.48 | 395,424.27 | 1,748,062.97 | 11,498,341.35 | 695,999.67 |

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[c] For two years.
[d] Including tuition fees.

TABLE 6.—*Additions to equipment of land-grant colleges, 1904.*

| State or Territory. | Permanent endowment. | Buildings. | Library. | Apparatus. | Machinery. | Live stock. | Miscellaneous. | Total. |
|---|---|---|---|---|---|---|---|---|
| Alabama (Auburn) | | | $1,900.00 | $1,200.00 | $4,000.00 | $1,000.00 | $300.00 | $8,400.00 |
| Alabama (Normal) | | $1,000.00 | 10,000.00 | | 600.00 | 150.00 | 265.00 | 12,015.00 |
| Arizona | | 26,900.00 | 2,609.20 | 3,274.39 | 1,920.00 | 400.00 | 725.00 | 35,828.59 |
| Arkansas (Fayetteville) | | 20,000.00 | 500.00 | 7,000.00 | 8,000.00 | | 500.00 | 36,000.00 |
| Arkansas (Pine Bluff) | | | | | | | | |
| California | $11,990.25 | 45,553.61 | | | | | | 57,543.86 |
| Colorado | | 42,172.31 | 6,602.16 | 3,000.00 | | | 1,500.00 | 53,274.47 |
| Connecticut | | 2,527.34 | 424.79 | 923.39 | | 3,055.74 | 2,155.05 | 9,086.31 |
| Delaware (Newark) | | 8,000.00 | 1,000.00 | 500.00 | 900.00 | | 900.00 | 11,300.00 |
| Delaware (Dover) | | | | | | | | |
| Florida (Lake City) | | 9,598.95 | 800.39 | | | 14,377.50 | | 24,776.84 |
| Florida (Tallahassee) | | | | | | | | |
| Georgia (Athens) | | 50,000.00 | 2,000.00 | 4,000.00 | | 600.00 | 1,000.00 | 57,600.00 |
| Georgia (College) | | | | | | | | |
| Idaho | 17,716.95 | | 1,463.16 | 2,425.01 | 3,314.34 | 2,938.11 | 688.53 | 28,546.10 |
| Illinois | 5,195.00 | 100,000.00 | 20,000.00 | 10,000.00 | 10,000.00 | 10,000.00 | 6,000.00 | 161,195.00 |
| Indiana | | 97,000.00 | 500.00 | 2,500.00 | | 900.00 | 2,500.00 | 103,400.00 |
| Iowa | | 98,812.50 | | 1,904.21 | 18,000.00 | | 5,000.00 | 123,716.71 |
| Kansas | | 56,500.00 | 1,500.00 | 3,065.00 | 950.00 | | 21,500.00 | 83,515.00 |
| Kentucky (Lexington) | | 47,776.01 | 1,031.31 | 1,814.56 | 322.10 | 197.94 | 124.67 | 51,266.59 |
| Kentucky (Frankfort) | | 1,500.00 | 50.00 | 100.00 | | 215.00 | | 1,865.00 |
| Louisiana (Baton Rouge) | | 20,113.65 | 1,845.75 | 4,758.49 | 7,593.22 | | | 34,311.11 |
| Louisiana (New Orleans) | | | | 147.53 | | | 351.10 | 498.63 |
| Maine | | 40,000.00 | | | 1,000.00 | 800.00 | | 41,800.00 |
| Maryland (College Park) | | 50,000.00 | 250.00 | 2,500.00 | | | | 52,750.00 |
| Maryland (Princess Anne) | | | | | | | | |
| Massachusetts (Amherst) | | | | | | | | |
| Massachusetts (Boston) | 96,524.18 | | | | | | | 96,524.18 |
| Michigan | | | | | | | | |
| Minnesota | 32,271.96 | 105,000.00 | 7,136.00 | 21,900.00 | 2,450.00 | 702.18 | | 169,460.14 |
| Mississippi (Agricultural College) | | 26,641.55 | 628.86 | 3,573.90 | 3,384.90 | 6,345.00 | 9,155.60 | 49,729.81 |
| Mississippi (Westside) | | | | | | | | |
| Missouri (Columbia) | | | | | | | | |
| Missouri (Jefferson City) | | 10,000.00 | 1,000.00 | 200.00 | | 150.00 | | 11,350.00 |
| Montana | | 24,000.00 | 1,500.00 | 2,500.00 | 2,000.00 | | | 30,000.00 |
| Nebraska | 40,000.00 | 10,500.00 | | | 15,000.00 | | 3,000.00 | 68,500.00 |
| Nevada | | 2,086.77 | 704.63 | 382.19 | 1,003.21 | 695.85 | 2,250.53 | 7,123.18 |
| New Hampshire | | 7,000.00 | 1,390.00 | 1,817.96 | 300.00 | 735.00 | | 11,242.96 |
| New Jersey | 12,000.00 | 2,890.00 | 2,303.82 | 1,357.93 | | | 289.69 | 18,841.44 |
| New Mexico | | 7,182.55 | 1,280.00 | 950.00 | 250.00 | 90.00 | 250.00 | 10,002.55 |
| New York | 176,390.21 | 430,854.09 | 20,331.00 | | | | [b]20,828.58 | 648,403.88 |
| North Carolina (Raleigh) | | | 861.99 | 1,500.00 | 2,500.00 | 1,000.00 | 2,000.00 | 7,861.99 |
| North Carolina (Greensboro) | | | 111.60 | 467.96 | | 235.00 | | 814.56 |
| North Dakota | | 789.73 | 706.30 | 296.93 | 276.87 | 928.22 | 245.00 | 3,243.05 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ohio | 8,340.01 | 107,512.20 | 15,000.00 | 12,000.00 | 7,500.00 | 3,000.00 | 10,000.00 | 163,352.21 |
| Oklahoma (Stillwater) | | | 1,064.71 | 264.38 | 479.29 | 3,509.00 | 2,077.17 | 7,414.55 |
| Oklahoma (Langston) | | 500.00 | 300.00 | 200.00 | 1,000.00 | | 300.00 | 2,300.00 |
| Oregon | | | 821.56 | 6,000.00 | 2,487.40 | 575.00 | 682.94 | 10,566.90 |
| Pennsylvania | | 270,000.00 | 1,000.00 | | | | | 271,000.00 |
| Rhode Island | | | 1,193.01 | 500.00 | | | | 1,693.01 |
| South Carolina (Clemson College) | | 43,040.83 | 1,000.00 | 566.55 | | 2,796.00 | | 47,403.38 |
| South Carolina (Orangeburg) | | | | 309.77 | | | 214.23 | 524.00 |
| South Dakota | | 38,420.00 | 450.00 | 800.00 | 7,500.00 | 2,500.00 | | 49,670.00 |
| Tennessee | | 906.94 | 821.67 | 1,374.09 | 1,057.99 | 581.00 | 1,023.63 | 5,765.32 |
| Texas (College Station) | | 37,500.00 | 1,000.00 | 20,000.00 | 2,000.00 | | | 60,500.00 |
| Texas (Prairie View) | | 1,500.00 | 200.00 | 1,000.00 | 1,500.00 | | | 4,200.00 |
| Utah | 150,376.80 | 21,089.36 | 2,246.98 | 2,656.27 | 6,254.45 | 436.55 | 9,288.00 | 192,348.41 |
| Vermont | 30,794.74 | | 2,000.00 | 500.00 | 300.00 | | | 33,594.74 |
| Virginia (Blacksburg) | | | | | | | | |
| Virginia (Hampton) | 57,000.00 | 45,000.00 | 500.00 | | | | | 102,500.00 |
| Washington | | 8,000.00 | 1,000.00 | 3,115.54 | 6,279.50 | | 1,784.60 | 20,179.64 |
| West Virginia (Morgantown) | | 10,000.00 | 3,228.00 | 2,500.00 | 575.00 | | | 16,303.00 |
| West Virginia (Institute) | | 11,000.00 | 150.00 | 490.00 | 754.00 | 80.00 | 655.00 | 13,129.00 |
| Wisconsin | | | 18,439.30 | | a 21,113.04 | 7,469.15 | 24,875.54 | 71,897.03 |
| Wyoming | | 17,400.00 | 1,902.19 | 3,129.90 | 817.63 | 1,046.80 | 1,548.87 | 25,845.39 |
| Total | 638,600.10 | 1,956,268.39 | 142,768.38 | 139,465.95 | 143,382.94 | 67,509.04 | 133,978.73 | 3,221,973.53 |

a Including apparatus.

b Including apparatus, machinery, and live stock.

TABLE 7.—*Disbursements from the United States Treasury to the States and Territories of the appropriations in aid of colleges of agriculture and the mechanic arts under the act of Congress approved August 30, 1890.*([a])

| State or Territory. | Year ending June 30— | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. |
| Alabama | $15,000 | $16,000 | $17,000 | $18,000 | $19,000 | $20,000 | $21,000 | $22,000 | $23,000 | $24,000 | $25,000 | $25,000 | $25,000 | $25,000 | $25,000 | $25,000 |
| Arizona | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Arkansas | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| California | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Colorado | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Connecticut | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Delaware | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Florida | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Georgia | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Idaho | | | | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Illinois | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Indiana | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Iowa | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Kansas | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Kentucky | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Louisiana | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Maine | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Maryland | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Massachusetts | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Michigan | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Minnesota | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Mississippi | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Missouri | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Montana | | | | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Nebraska | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Nevada | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| New Hampshire | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| New Jersey | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| New Mexico | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| New York | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| North Carolina | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| North Dakota | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Ohio | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Oklahoma | | | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Oregon | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Pennsylvania | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Rhode Island | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| South Carolina | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| South Dakota | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Tennessee | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Texas | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utah | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Vermont | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Virginia | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Washington | | | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| West Virginia | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Wisconsin | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Wyoming | 15,000 | 16,000 | 17,000 | 18,000 | 19,000 | 20,000 | 21,000 | 22,000 | 23,000 | 24,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Total | 660,000 | 704,000 | 782,000 | 864,000 | 912,000 | 960,000 | 1,008,000 | 1,056,000 | 1,104,000 | 1,152,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,200,000 | 1,200,000 |

[a] From the annual statement of Commissioner of Education to the Secretary of the Interior, 1904.

## STATISTICS OF THE AGRICUL

TABLE 8.—*General*

| Station. | Location. | Director. | Date of original organization. | Date of organization under Hatch Act. |
|---|---|---|---|---|
| Alabama (College) | Auburn | J. F. Duggar, M. S | Feb. —, 1883 | Feb. 24, 1888 |
| Alabama (Canebrake) | Uniontown | J. M. Richeson, M. S.[a] | Jan. 1, 1886 | Apr. 1, 1888 |
| Alabama | Tuskegee Institute | G. W. Carver | Feb. 15, 1897 | |
| Arizona | Tucson | R. H. Forbes, M. S | | 1889 |
| Arkansas | Fayetteville | W. G. Vincenheller | | 1887 |
| California | Berkeley | E. W. Hilgard, Ph. D., LL.D. | 1875 | Mar. —, 1888 |
| Colorado | Fort Collins | L. G. Carpenter, M. S. | 1879 | Feb. —, 1888 |
| Connecticut (State) | New Haven | E. H. Jenkins, Ph. D | Oct. 1, 1875 | May 18, 1887 |
| Connecticut (Storrs) | Storrs | L. A. Clinton, M. S | | do |
| Delaware | Newark | A. T. Neale, Ph. D. | | Feb. 21, 1888 |
| Florida | Lake City | Andrew Sledd, Ph.D. | | 1888 |
| Georgia | Experiment | R. J. Redding | Feb. 18, 1888 | July 1, 1889 |
| Idaho | Moscow | H. T. French, M. S | | Feb. 26, 1892 |
| Illinois | Urbana | Eugene Davenport, M. Agr. | | Mar. 21, 1888 |
| Indiana | Lafayette | Arthur Goss, M. S., A. C. | 1885 | Jan. —, 1888 |
| Iowa | Ames | C. F. Curtiss, M. S. A. | | Feb. 17, 1888 |
| Kansas | Manhattan | J. T. Willard, M. S. | | Feb. 8, 1888 |
| Kentucky | Lexington | M. A. Scovell, M. S | Sept. —, 1885 | Apr. —, 1888 |
| Louisiana (Sugar) | New Orleans | W. R. Dodson, B. A., B. S. | Sept. —, 1885 | |
| Louisiana (State) | Baton Rouge | do | Apr. —, 1886 | |
| Louisiana (North) | Calhoun | do | May —, 1887 | |

[a] Assistant director.

## TURAL EXPERIMENT STATIONS.

*statistics, 1904.*

| Number on staff. | Number of teachers on staff. | Number of persons on staff who assist in farmers' institutes. | Publications during fiscal year 1903-4. | | Number of addresses on mailing list. | Principal lines of work. |
|---|---|---|---|---|---|---|
| | | | Number. | Pages. | | |
| 14 | 10 | 7 | 5 | 195 | 12,500 | Botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; dairying. |
| 3 | ...... | 2 | 3 | 52 | 1,500 | Soil improvement; field experiments; horticulture; floriculture; diseases of plants and animals. |
| 10 | 7 | 8 | ...... | ........ | 9 | Field experiments; horticulture; diseases of plants; animal industry; dairying. |
| 6 | 3 | 4 | 4 | 188 | 7,451 | Chemistry; botany; field experiments; improvement of ranges; horticulture, including date-palm culture; feeding experiments; dairying; irrigation. |
| 6 | 2 | 4 | 8 | 180 | 9,250 | Chemistry; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology. |
| 37 | 19 | 18 | 12 | 447 | 9,200 | Chemistry; soils; bacteriology; fertilizer control; field crops; horticulture, including viticulture and zymology; botany; meteorology; animal husbandry; entomology; dairying; poultry culture; drainage and irrigation; sylviculture; reclamation of alkali lands; animal and plant pathology; nutrition investigations. |
| 15 | 9 | 6 | 9 | 98 | 8,000 | Chemistry; meteorology; field experiments; horticulture; plant breeding; diseases of plants; animal husbandry; entomology; irrigation. |
| 17 | ...... | 5 | 3 | 565 | 12,000 | Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; horticulture; forestry; field experiments; entomology. |
| 15 | 10 | 6 | 6 | 314 | 9,000 | Food and nutrition of man and animals; bacteriology of dairy products; field experiments; horticulture; poultry experiments; dairying. |
| 6 | 6 | 5 | 4 | 80 | 7,348 | Chemistry; bacteriology; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; dairying. |
| 14 | 8 | 5 | 5 | 152 | 3,718 | Chemistry; field experiments; horticulture; feeding experiments; veterinary science; entomology. |
| 7 | 1 | 5 | 4 | 96 | 13,000 | Field experiments; horticulture; entomology; feeding experiments; dairying. |
| 10 | 6 | 6 | 5 | 112 | 5,250 | Chemistry; physics; botany; field experiments; horticulture; plant breeding and diseases; entomology; feeding experiments. |
| 33 | 19 | 25 | 15 | 372 | 25,250 | Chemistry; bacteriology; pot and field experiments; horticulture; forestry; plant breeding; animal husbandry; diseases of plants and animals; entomology; dairying. |
| 10 | 8 | 9 | 5 | 103 | 9,724 | Chemistry; soils; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals; entomology. |
| 35 | 20 | 12 | 7 | 589 | 12,300 | Chemistry; botany; field experiments; horticulture; plant breeding; forestry; diseases of plants; animal husbandry; entomology; dairying; rural engineering; good roads investigations. |
| 18 | 13 | 14 | 6 | 282 | 21,165 | Soils; horticulture; plant breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers. |
| 14 | 1 | 4 | 7 | 488 | 9,000 | Chemistry; soils; analysis of fertilizers, foods, and feeding stuffs; inspection of orchards and nurseries; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants; entomology; dairying. |
| 25 | 3 | 12 | 5 | 156 | 15,000 | Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.<br>Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.<br>Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying. |

TABLE 8.—*General*

| Station. | Location. | Director. | Date of original organization. | Date of organization under Hatch Act. |
|---|---|---|---|---|
| Maine | Orono | C. D. Woods, B. S | Mar. —, 1885 | Oct. 1, 1887 |
| Maryland | College Park | H. J. Patterson, B. S | 1888 | Apr. —, 1888 |
| Massachusetts | Amherst | H. H. Goodell, LL. D | [a] 1882 | Mar. 2, 1888 |
| Michigan | Agricultural College | C. D. Smith, M. S | | Feb. 25, 1888 |
| Minnesota | St. Anthony Park | W. M. Liggett | Mar. 7, 1885 | 1888 |
| Mississippi | Agricultural College | W. L. Hutchinson, M. S. | | Jan. 27, 1888 |
| Missouri (State) | Columbia | H. J. Waters, B. S. A | | Jan. —, 1888 |
| Missouri (Fruit) | Mountain Grove | Paul Evans | Feb. 1, 1900 | |
| Montana | Bozeman | F. B. Linfield, B. S. A | | July 1, 1893 |
| Nebraska | Lincoln | E. A. Burnett, B. S | Dec. 16, 1884 | June 13, 1887 |
| Nevada | Reno | J. E. Stubbs, M. A., D. D | | |
| New Hampshire | Durham | W. D. Gibbs, M. S | 1886 | Aug. 4, 1887 |
| New Jersey (State) | New Brunswick | E. B. Voorhees, D. Sc | Mar. 10, 1880 | |
| New Jersey (College) | do | do | | Apr. 26, 1888 |
| New Mexico | Mesilla Park | Luther Foster, M. S. A | | Dec. 14, 1889 |
| New York (State) | Geneva | W. H. Jordan, D. Sc | Mar. —, 1882 | |
| New York (Cornell) | Ithaca | L. H. Bailey, M. S | 1879 | Apr. —, 1888 |
| North Carolina | Raleigh | B. W. Kilgore, M. S | Mar. 12, 1877 | Mar. 7, 1887 |
| North Dakota | Agricultural College | J. H. Worst, LL. D | | Mar. —, 1890 |
| Ohio | Wooster | C. E. Thorne, M. S. A | Apr. 25, 1882 | Apr. 2, 1888 |
| Oklahoma | Stillwater | John Fields, B. S | | Dec. 25, 1890 |

[a] In 1882 the State organized a station here and maintained it until

*statistics, 1904*—Continued.

| Number on staff. | Number of teachers on staff. | Number of persons on staff who assist in farmers' institutes. | Publications during fiscal year 1903-4. Number. | Publications during fiscal year 1903-4. Pages. | Number of addresses on mailing list. | Principal lines of work. |
|---|---|---|---|---|---|---|
| 12 | 4 | 4 | 12 | 276 | 9,000 | Chemistry; botany; analysis and inspection of fertilizers, concentrated commercial feeding stuffs; inspection of creamery glassware; horticulture; plant breeding; diseases of plants and animals; seed tests; food and nutrition of man and animals; poultry raising; entomology; dairying. |
| 15 | 9 | 5 | 9 | 159 | 14,000 | Fertilizers; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; animal breeding; entomology; dairying. |
| 21 | 9 | 5 | 10 | 473 | 32,250 | Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; diseases of plants and animals; digestion and feeding experiments; entomology; dairying; effect of electricity on plant growth. |
| 11 | 5 | 7 | 17 | 831 | 35,000 | Chemistry; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding experiments; entomology; stable hygiene. |
| 15 | 7 | ........ | 4 | 317 | 13,500 | Chemistry; fertilizers; field experiments; horticulture; forestry; diseases of plants and animals; food and nutrition of man; plant and animal breeding; feeding experiments; entomology; dairying; farm management; farm statistics. |
| 12 | 5 | 7 | 8 | 175 | 20,000 | Soils; fertilizers; field experiments; horticulture; animal husbandry; diseases of animals; poultry culture; entomology; dairying. |
| 21 | 12 | 11 | 7 | 177 | 7,000 | Chemistry; botany; field experiments; horticulture; diseases of plants and animals; feeding experiments; animal and plant breeding; entomology; dairying; drainage and irrigation. |
| 4 | ...... | ........ | 3 | 57 | 4,500 | Horticulture; entomology; inspection of orchards and nurseries. |
| 11 | 10 | 8 | 10 | 378 | 3,996 | Chemistry; meteorology; botany; field experiments; horticulture; feeding experiments; poultry experiments; entomology; dairying; irrigation. |
| 17 | 13 | 10 | 6 | 250 | 20,740 | Chemistry; botany; field experiments; horticulture; plant breeding; diseases of plants and animals; forestry; feeding and breeding experiments; extermination of prairie dogs; entomology; dairying; irrigation. |
| 9 | 6 | 7 | 4 | 120 | 2,933 | Chemistry; botany; soils; field experiments; horticulture; forestry; animal diseases; entomology; irrigation. |
| 12 | 7 | 4 | 8 | 132 | 13,000 | Chemistry; field experiments; horticulture; plant breeding; forestry; feeding experiments; entomology; dairying. |
| 13<br>8 | 2<br>4 | 2<br>2 | 9 | 945 | 10,500 | Chemistry; oyster culture; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; plant breeding; diseases of plants and animals; entomology; dairy husbandry; soil bacteriology; irrigation. |
| 12 | 8 | 5 | 8 | 296 | 3,000 | Chemistry; botany; field experiments; horticulture; soils; feeding experiments; entomology; irrigation. |
| 25 | ...... | 11 | 32 | 1,150 | 45,000 | Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation. |
| 19 | 18 | 14 | 9 | 198 | 12,000 | Chemistry; fertilizers; field experiments; horticulture, plant breeding; diseases of plants and animals; feeding experiments; poultry experiments; entomology; dairying. |
| 14 | 8 | 8 | 4 | 120 | 26,000 | Chemistry; soils; field experiments; horticulture; diseases of plants and animals; animal husbandry; poultry experiments; dairying; tests of farm machinery. |
| 15 | 9 | 5 | 6 | 409 | 10,500 | Chemistry; botany; field experiments; plant breeding; horticulture; forestry; diseases of plants and animals; food analysis; feeding experiments; dairying; tests of farm machinery. |
| 22 | ...... | 8 | 6 | 80 | 45,000 | Soils; field experiments; horticulture; plant breeding; diseases of plants and animals; breeding and feeding experiments; entomology. |
| 11 | 9 | 5 | 6 | 340 | 20,889 | Chemistry; field experiments; horticulture; plant breeding; forestry; botany; diseases of plants and animals; animal husbandry; entomology. |

June 18, 1895, when it became a part of the Hatch Station at the same place.

TABLE 8.—*General*

| Station. | Location. | Director. | Date of original organization. | Date of organization under Hatch Act. |
|---|---|---|---|---|
| Oregon | Corvallis | James Withycombe, M. Agr. |  | July —, 1888 |
| Pennsylvania | State College | H. P. Armsby, Ph. D. |  | June 30, 1887 |
| Rhode Island | Kingston | H. J. Wheeler, Ph. D. |  | July 30, 1888 |
| South Carolina | Clemson College | P. H. Mell, M. E., Ph. D. |  | Jan. —, 1888 |
| South Dakota | Brookings | J. W. Wilson, M. S. A. |  | Mar. 13, 1887 |
| Tennessee | Knoxville | H. A. Morgan | June 8, 1882 | Aug. 4, 1887 |
| Texas | College Station | J. A. Craig, B. S. A. |  |  |
| Utah | Logan | J. A. Widtsoe, Ph. D. |  | 1890 |
| Vermont | Burlington | J. L. Hills, D. Sc. | Nov. 24, 1886 | Feb. 28, 1888 |
| Virginia | Blacksburg | A. M. Soule, B. S. A. | 1888 | 1891 |
| Washington | Pullman | E. A. Bryan, LL. D. |  | 1891 |
| West Virginia | Morgantown | J. H. Stewart, M. A. |  | June 11, 1888 |
| Wisconsin | Madison | W. A. Henry, D. Agr. | 1883 | 1887 |
| Wyoming | Laramie | B. C. Buffum, M. S. | 1887 | Mar. 1, 1891 |
| Total |  |  |  |  |

*statistics, 1904*—Continued.

| Number on staff. | Number of teachers on staff. | Number of persons on staff who assist in farmers' institutes. | Publications during fiscal year 1903-4. | | Number of addresses on mailing list. | Principal lines of work. |
|---|---|---|---|---|---|---|
| | | | Number. | Pages. | | |
| 11 | 10 | 4 | 5 | 146 | 5,100 | Chemistry; bacteriology; soils; fertilizers; field crops; horticulture; plant selection; diseases of plants; feeding experiments; entomology; dairying; irrigation. |
| 20 | 7 | 2 | 5 | 281 | 15,365 | Chemistry; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture; field experiments; feeding experiments; dairying. |
| 11 | 5 | 4 | 8 | 320 | 10,000 | Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; plant breeding; poultry experiments. |
| 17 | 11 | 10 | 10 | 173 | 11,000 | Chemistry; analysis and control of fertilizers; botany; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying. |
| 17 | 9 | ........ | 8 | 194 | 9,000 | Chemistry; botany; horticulture; soils; field experiments; plant breeding; diseases of plants and animals; animal husbandry; entomology; irrigation. |
| 9 | 8 | 7 | 5 | 104 | 11,050 | Chemistry; inspection of fertilizers; field experiments; horticulture; plant breeding; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying. |
| 12 | 8 | 8 | 5 | 134 | 20,200 | Chemistry; soils; field experiments; horticulture; feeding experiments; diseases of animals; irrigation. |
| 15 | 9 | 11 | 7 | 238 | 6,000 | Chemistry of soils and feeding stuffs; alkali soil investigations; field experiments; horticulture; breeding and feeding experiments; dairying; poultry experiments; entomology; irrigation; arid farming. |
| 12 | 6 | 4 | 10 | 556 | 11,413 | Chemistry; botany; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying. |
| 18 | 8 | 4 | 11 | 232 | 12,000 | Chemistry; geology; biology; field experiments; horticulture; bacteriology; analysis of foods and soils; inspection of orchards; feeding experiments; veterinary science; entomology; cider and vinegar making; ferments. |
| 12 | 12 | 12 | 2 | 49 | 5,000 | Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants and animals; feeding and breeding experiments; entomology; dairying; irrigation. |
| 15 | 6 | 7 | 6 | 207 | 8,700 | Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology. |
| 23 | 21 | 5 | 15 | 882 | 17,000 | Chemistry; bacteriology; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation; farm engineering. |
| 9 | 4 | ........ | 5 | 225 | 3,500 | Botany; meteorology; soils; range improvement; fertilizers; field experiments; plant selection; food analysis; breeding and feeding experiments; irrigation. |
| 795 | 414 | 363 | 393 | 15,093 | 685,301 | |

TABLE 9.—*Revenue and addi*

| Station. | Hatch fund. | State. | Individuals and communities. | Fees. | Farm products. |
|---|---|---|---|---|---|
| Alabama (College) | $15,000.00 | | | $11,202.41 | $409.63 |
| Alabama (Canebrake) | | $2,500.00 | | | 800.00 |
| Alabama (Tuskegee) | | 1,500.00 | | | |
| Arizona | 15,000.00 | 313.39 | | 20.90 | 528.48 |
| Arkansas | 14,999.67 | | | | 863.83 |
| California | 15,000.00 | 6,139.91 | | | 1,624.06 |
| Colorado | 15,000.00 | | | | |
| Connecticut (State) | 7,500.00 | 15,500.00 | $6,900.00 | [a]3,831.56 | 28.00 |
| Connecticut (Storrs) | 7,500.00 | 1,800.00 | | | |
| Delaware | 15,000.00 | | | | |
| Florida | 15,000.00 | | | | 1,722.21 |
| Georgia | 15,000.00 | 757.96 | | | 2,496.54 |
| Idaho | 15,000.00 | 955.79 | | | 844.15 |
| Illinois | 15,000.00 | 85,000.00 | | 870.00 | 585.73 |
| Indiana | 15,000.00 | | | | 2,416.72 |
| Iowa | 15,000.00 | 10,000.00 | 400.00 | 41.43 | 4,420.48 |
| Kansas | 15,000.00 | [d]17,900.00 | | | 4,184.55 |
| Kentucky | 15,000.00 | [a]10,208.18 | | [a]19,982.42 | [a]8,277.86 |
| Louisiana | 15,000.00 | 20,000.00 | | 11,558.72 | 2,574.93 |
| Maine | 15,000.00 | | | 4,525.00 | 1,576.18 |
| Maryland | 15,000.00 | 5,000.00 | | | 4,468.25 |
| Massachusetts | 15,000.00 | 13,000.00 | | 4,204.58 | 2,714.79 |
| Michigan | 15,000.00 | [d]5,500.00 | | 2,140.00 | 2,376.73 |
| Minnesota | 15,000.00 | [e]35,362.88 | | | [e]10,205.74 |
| Mississippi | 15,000.00 | [f]20,000.00 | | | 2,062.07 |
| Missouri (College) | 15,000.00 | 3,000.00 | | 4,323.09 | 3,124.41 |
| Missouri (Fruit) | | 21,259.61 | | | |
| Montana | 15,000.00 | 24,011.71 | | | 3,871.02 |
| Nebraska | 15,000.00 | | | | [a]7,537.76 |
| Nevada | 15,000.00 | | | | 712.04 |
| New Hampshire | 15,000.00 | | | 1,129.21 | |
| New Jersey (State) | | 26,000.00 | | | |
| New Jersey (College) | 15,000.00 | | | | |
| New Mexico | 15,000.00 | | | | 1,827.61 |
| New York (State) | 1,500.00 | [g]76,352.86 | | | |
| New York (Cornell) | 13,500.00 | [h]23,333.34 | | | |
| North Carolina | 15,000.00 | [i]5,000.00 | | | 2,195.77 |
| North Dakota | 15,000.00 | [d]750.00 | | | 4,549.90 |
| Ohio | 15,000.00 | [a]61,831.45 | | 355.70 | [a]7,354.04 |
| Oklahoma | 15,000.00 | 1,421.78 | | | [a]2,598.67 |
| Oregon | 15,000.00 | | | | 1,708.13 |
| Pennsylvania | 15,000.00 | 1,000.00 | | 15,420.60 | 4,258.51 |
| Rhode Island | 15,000.00 | | | | 534.53 |
| South Carolina | 15,000.00 | | | | 3,815.10 |
| South Dakota | 15,000.00 | 1,500.00 | | | |
| Tennessee | 15,000.00 | | | 520.00 | 4,999.78 |
| Texas | 15,000.00 | [d]5,000.00 | | | 200.02 |
| Utah | 15,000.00 | | | | [a]488.59 |
| Vermont | 15,000.00 | 1,468.03 | | 2,548.47 | |
| Virginia | 15,000.00 | 25.00 | | | |
| Washington | 15,000.00 | | | | [a]830.78 |
| West Virginia | 15,000.00 | | | 9,596.73 | 2,403.27 |
| Wisconsin | 15,000.00 | 19,000.00 | | 1,800.00 | |
| Wyoming | 15,000.00 | | | | 2,168.57 |
| Total | 719,999.67 | 522,391.89 | 7,300.00 | 94,070.82 | 110,359.43 |

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[a] Including balance from previous year.

[b] Portion spent for agricultural research of fund of $29,584.39 for salaries and running expenses for the department of agriculture.

[c] Balance from previous year.

[d] For substations.

[e] Including substations.

*tions to equipment in 1904.*

| Miscellaneous. | Total. | Additions to equipment in 1904. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Buildings. | Library. | Apparatus. | Farm implements. | Live stock. | Miscellaneous. | Total. |
| $829.40 | $27,441.44 | $700.00 | $578.00 | $1,125.00 | $75.00 | $1,000.00 | $185.00 | $3,663.00 |
| ........ | 3,300.00 | 5,000.00 | 250.00 | ........ | 50.00 | 200.00 | ........ | 5,500.00 |
| ........ | 1,500.00 | ........ | 75.00 | 60.00 | 150.00 | 75.00 | 200.00 | 560.00 |
| [a]281.58 | 16,244.35 | 513.71 | 5.12 | 97.20 | 387.68 | 9.50 | 131.37 | 1,144.58 |
| ........ | 15,863.50 | 750.00 | 117.81 | 39.16 | ........ | 9.00 | ........ | 915.97 |
| [b]10,000.00 | 32,763.97 | 3,540.00 | 500.00 | 2,400.00 | 700.00 | 2,650.00 | 14,210.00 | 24,000.00 |
| 1,313.59 | 16,313.59 | ........ | 75.28 | 635.01 | ........ | ........ | ........ | 710.29 |
| [a]1,002.08 | 34,761.64 | ........ | 494.74 | 81.98 | ........ | ........ | ........ | 576.72 |
| 15.71 | 9,315.71 | ........ | ........ | 534.78 | 170.48 | 315.55 | 257.50 | 1,278.26 |
| ........ | 15,000.00 | 544.65 | 469.63 | 357.23 | 32.64 | 24.05 | ........ | 1,428.20 |
| ........ | 16,722.21 | 1,557.71 | 164.18 | 975.87 | 178.30 | 389.33 | 15.98 | 3,281.32 |
| [a]4,494.76 | 22,749.26 | 1,200.00 | 200.00 | 175.00 | 352.00 | ........ | 550.00 | 2,477.00 |
| ........ | 16,799.94 | 429.22 | 108.67 | 445.38 | 317.17 | 2,608.35 | ........ | 3,908.79 |
| [c]1,637.54 | 103,093.27 | 674.61 | 238.69 | 3,737.00 | 1,204.50 | 7,422.78 | ........ | 13,277.58 |
| ........ | 17,416.72 | 348.16 | 194.51 | ........ | 188.27 | 55.91 | ........ | 786.85 |
| 185.95 | 30,047.86 | 631.67 | ........ | 219.10 | 320.33 | ........ | 1,382.97 | 2,554.07 |
| [c]1,164.84 | 38,249.39 | 386.82 | 166.12 | 606.58 | 486.44 | 1,041.94 | 412.84 | 3,100.69 |
| [a]323.01 | 53,791.47 | 18,911.01 | 474.40 | 149.56 | 322.10 | 197.94 | 124.67 | 20,179.68 |
| [c]10,097.00 | 59,230.65 | 479.53 | 152.31 | 31.30 | 585.66 | 75.35 | 3,133.02 | 4,457.17 |
| [c]120.86 | 21,222.04 | 2,105.00 | 265.45 | 172.65 | 231.31 | ........ | ........ | 2,774.41 |
| [c]142.29 | 24,610.54 | 1,548.82 | 298.84 | 40.62 | 615.16 | 802.00 | 245.00 | 3,550.44 |
| [a]6,805.48 | 41,724.85 | ........ | 247.50 | 1,270.77 | 62.51 | 689.25 | ........ | 2,270.03 |
| [a]3,799.25 | 28,815.98 | 6.77 | 293.99 | 490.04 | 46.67 | 360.00 | 80.50 | 1,277.97 |
| ........ | 60,568.62 | 5,000.00 | 180.14 | 5,898.67 | 222.04 | 1,786.08 | ........ | 12,996.93 |
| [a]225.85 | 37,287.92 | 90.00 | 100.00 | 300.00 | ........ | 500.00 | ........ | 990.00 |
| [c]178.29 | 25,625.79 | 412.26 | 96.98 | 101.35 | 25.00 | 1,039.50 | 117.33 | 1,792.42 |
| ........ | 21,259.61 | 1,200.00 | ........ | ........ | ........ | ........ | ........ | 1,200.00 |
| ........ | 42,882.73 | 14,000.00 | ........ | 500.00 | 200.00 | 500.00 | ........ | 15,200.00 |
| ........ | 22,537.76 | 79,000.00 | 11.20 | 582.50 | 400.04 | 833.13 | 905.75 | 81,732.62 |
| [c]155.94 | 15,867.98 | 128.89 | ........ | 237.10 | 84.18 | 695.85 | ........ | 1,146.02 |
| ........ | 16,129.21 | 228.11 | 173.82 | 515.33 | 266.28 | 78.00 | 404.91 | 1,666.45 |
| ........ | 26,000.00 | 2,153.15 | 66.95 | 600.00 | ........ | ........ | ........ | 2,820.10 |
| ........ | 15,000.00 | 374.24 | 765.18 | 210.86 | ........ | ........ | 289.69 | 1,639.92 |
| 250.00 | 17,077.61 | ........ | 500.00 | 100.00 | 3,500.00 | 350.00 | ........ | 4,450.00 |
| ........ | 77,852.86 | 5,000.00 | 692.59 | ........ | 1,000.00 | 640.00 | ........ | [g]7,332.59 |
| ........ | 36,833.34 | 150.00 | 250.00 | 500.00 | 100.00 | 600.00 | 300.00 | 1,900.00 |
| ........ | 22,195.77 | 927.85 | 46.06 | 7.50 | 50.00 | 353.30 | ........ | 1,384.71 |
| 181.00 | 20,480.90 | 65.30 | ........ | 55.89 | 154.82 | 928.22 | 218.00 | 1,422.23 |
| 6,375.48 | 90,916.67 | 6,918.05 | 1,058.87 | 1,098.40 | 2,413.58 | 627.25 | ........ | 12,116.15 |
| ........ | 19,020.45 | 50.29 | 79.67 | 95.46 | 211.01 | 300.00 | 30.00 | 766.43 |
| ........ | 16,708.13 | ........ | 80.41 | ........ | 347.64 | 125.00 | ........ | 553.05 |
| 98.81 | 35,777.92 | ........ | 481.22 | 322.85 | 213.00 | 464.00 | ........ | 1,481.07 |
| [a]2,256.47 | 17,791.00 | 764.48 | 605.04 | 116.36 | 107.02 | 28.35 | 531.04 | 2,152.29 |
| ........ | 18,815.10 | 576.48 | 60.49 | 11.00 | 330.42 | 1,164.30 | ........ | 2,142.69 |
| 1,736.12 | 18,236.12 | ........ | ........ | 350.00 | 142.00 | ........ | 385.00 | 877.00 |
| 4.18 | 20,523.96 | 587.50 | 230.72 | 184.99 | 122.00 | 515.00 | ........ | 1,590.21 |
| 596.00 | 20,796.02 | 487.24 | 96.22 | 240.87 | 85.50 | 480.00 | 285.88 | 1,675.71 |
| ........ | 15,488.59 | 151.27 | 47.42 | 21.81 | 468.20 | 205.80 | 23.80 | 918.30 |
| ........ | 19,016.50 | 1,660.97 | 58.59 | 176.97 | 268.48 | 1,075.00 | ........ | 3,235.01 |
| 191.90 | 15,216.90 | 211.83 | ........ | ........ | ........ | ........ | ........ | 211.83 |
| ........ | 15,830.78 | 471.05 | ........ | 415.00 | ........ | ........ | 100.00 | 986.05 |
| 135.06 | 27,135.06 | 2,372.98 | 347.88 | 1,581.86 | 464.81 | 47.00 | 184.35 | 4,998.88 |
| ........ | 35,800.00 | 3,827.87 | 964.45 | 1,817.87 | 583.69 | 1,757.41 | 5,077.22 | 14,028.51 |
| ........ | 17,168.57 | 2,000.00 | 500.00 | 400.00 | 124.75 | 1,046.80 | 300.00 | 4,371.55 |
| 54,698.44 | 1,508,820.25 | 168,087.44 | 12,859.04 | 29,996.77 | 18,360.68 | 34,065.94 | 30,081.82 | 293,451.69 |

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[f] **For substations, including $14,000 for McNeill Station** for two years.

[g] For year ended September 30, 1904.

[h] Estimated amount of State and other appropriations, not included in Hatch fund, spent for experimental purposes.

[i] Estimated amount of State appropriation spent for experimental purposes.

TABLE 10.—*Expenditures from United States*

| Station. | Amount. | Itemized. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Salaries. | Labor. | Publications. | Postage and stationery. | Freight and express. | Heat, light, and water. | Chemical supplies. |
| Alabama | $15,000.00 | $7,701.21 | $1,485.46 | $857.35 | $159.83 | $364.18 | $356.95 | $749.17 |
| Arizona | 15,000.00 | 7,873.36 | 3,913.91 | ........ | 237.02 | 228.40 | 107.83 | 52.10 |
| Arkansas | 15,000.00 | 7,246.26 | 1,901.86 | 736.05 | 298.67 | 155.11 | 136.29 | 349.87 |
| California | 15,000.00 | 6,020.96 | 5,194.39 | 100.00 | 564.48 | 174.35 | 353.75 | 184.65 |
| Colorado | 15,000.00 | 12,277.45 | 164.45 | 709.31 | 211.61 | 6.94 | 6.75 | 2.50 |
| Connecticut (State) | 7,500.00 | 7,500.00 | ........ | ........ | ........ | ........ | ........ | ........ |
| Connecticut (Storrs) | 7,500.00 | 3,160.13 | 1,185.32 | 51.81 | 252.98 | 67.35 | 368.13 | 403.89 |
| Delaware | 15,000.00 | 9,721.25 | 1,144.23 | 484.43 | 131.32 | 122.92 | 407.63 | 125.97 |
| Florida | 15,000.00 | 7,765.07 | 1,561.87 | 689.42 | 432.77 | 240.88 | 553.45 | 236.38 |
| Georgia | 15,000.00 | 7,630.00 | 2,364.43 | 1,443.43 | 190.25 | 263.79 | 247.68 | 7.95 |
| Idaho | 15,000.00 | 8,284.80 | 2,462.06 | 536.45 | 150.09 | 216.74 | ........ | 238.54 |
| Illinois | 15,000.00 | 7,368.80 | 2,799.69 | 787.64 | 656.55 | 336.18 | 279.27 | 88.73 |
| Indiana | 15,000.00 | 7,779.50 | 3,504.79 | 769.32 | 107.58 | 115.61 | 249.71 | 6.30 |
| Iowa | 15,000.00 | 9,430.72 | ........ | 2,355.77 | 263.63 | 207.82 | ........ | 172.99 |
| Kansas | 15,000.00 | 7,953.46 | 3,418.08 | 769.84 | 142.96 | 238.04 | 29.95 | 344.58 |
| Kentucky | 15,000.00 | 11,961.67 | 738.09 | 444.87 | 183.40 | 46.73 | 401.20 | 70.71 |
| Louisiana | 15,000.00 | 8,686.32 | 2,742.86 | 1,262.19 | 364.67 | 104.99 | 320.76 | 36.05 |
| Maine | 15,000.00 | 7,845.80 | 2,093.57 | 241.26 | 226.68 | 217.16 | 443.07 | 359.44 |
| Maryland | 15,000.00 | 7,259.78 | 2,927.98 | 209.31 | 181.73 | 497.44 | 414.90 | 260.68 |
| Massachusetts | 15,000.00 | 6,012.05 | 3,070.03 | 1,017.89 | 297.42 | 116.30 | 477.95 | 25.40 |
| Michigan | 15,000.00 | 6,755.24 | 3,436.22 | 67.94 | 520.46 | 292.42 | 7.60 | 278.85 |
| Minnesota | 15,000.00 | 10,499.88 | 2,350.00 | ........ | 175.00 | ........ | 697.54 | ........ |
| Mississippi | 15,000.00 | 7,373.07 | 1,292.86 | 434.51 | 186.49 | 217.39 | 106.80 | 240.81 |
| Missouri | 15,000.00 | 5,327.67 | 2,654.00 | 568.50 | 210.96 | 147.14 | 311.10 | 149.94 |
| Montana | 15,000.00 | 8,439.32 | 1,978.48 | 2,932.41 | 341.42 | 337.58 | 60.94 | 196.92 |
| Nebraska | 15,000.00 | 9,057.55 | 1,409.33 | 1,614.98 | 443.64 | 97.99 | ........ | 211.16 |
| Nevada | 15,000.00 | 9,780.84 | 1,968.70 | 580.52 | 86.10 | 291.14 | 194.45 | 362.77 |
| New Hampshire | 15,000.00 | 8,549.29 | 1,807.16 | 1,858.45 | 82.18 | 141.48 | 123.25 | 140.15 |
| New Jersey | 15,000.00 | 9,383.67 | 901.11 | 1,507.67 | 543.68 | 108.11 | 239.61 | 95.44 |
| New Mexico | 15,000.00 | 6,784.99 | 2,698.14 | 746.47 | 315.35 | 485.75 | 654.88 | 68.13 |
| New York (State) | 1,500.00 | 120.00 | 3.30 | ........ | 46.14 | 6.16 | 212.52 | ........ |
| New York (Cornell) | 13,500.00 | 10,385.50 | 1,137.45 | 756.23 | 221.47 | 57.73 | ........ | 10.37 |
| North Carolina | 15,000.00 | 9,850.00 | 1,709.13 | 2,254.29 | 374.60 | 197.87 | 57.61 | 63.05 |
| North Dakota | 15,000.00 | 8,826.90 | 3,185.48 | 1,162.75 | 193.52 | 102.65 | 104.13 | 73.46 |
| Ohio | 15,000.00 | 11,376.67 | 456.74 | ........ | ........ | ........ | 674.21 | ........ |
| Oklahoma | 15,000.00 | 6,337.50 | 3,228.91 | 1,032.83 | 463.17 | 168.65 | 261.32 | 133.73 |
| Oregon | 15,000.00 | 10,530.00 | 2,398.02 | 240.17 | 63.53 | 99.26 | ........ | 166.42 |
| Pennsylvania | 15,000.00 | 9,924.79 | ........ | 825.00 | 266.06 | ........ | 579.02 | 1,054.36 |
| Rhode Island | 15,000.00 | 8,758.84 | 1,561.54 | 71.65 | 283.52 | 115.49 | 658.94 | 83.72 |
| South Carolina | 15,000.00 | 8,753.88 | 1,527.56 | 1,131.33 | 102.55 | 153.83 | 51.95 | 431.22 |
| South Dakota | 15,000.00 | 7,580.00 | 3,282.47 | 1,219.57 | 275.30 | 304.31 | 21.10 | 300.02 |
| Tennessee | 15,000.00 | 8,313.34 | 2,613.90 | 981.69 | 262.51 | 48.39 | 309.85 | 213.49 |
| Texas | 15,000.00 | 7,148.44 | 2,032.24 | 961.04 | 447.94 | 476.38 | 50.85 | 490.74 |
| Utah | 15,000.00 | 8,040.50 | 3,661.30 | 66.45 | 217.68 | 6.40 | ........ | 293.05 |
| Vermont | 15,000.00 | 7,361.92 | 2,837.74 | 1,168.64 | 438.07 | 121.24 | 372.86 | 124.04 |
| Virginia | 15,000.00 | 9,561.58 | 2.105.54 | 1,496.60 | 121.35 | 204.82 | 188.07 | 235.75 |
| Washington | 15.000.00 | 10,118.08 | 1,695.27 | 266.87 | 16.50 | 263.17 | 215.00 | 62.35 |
| West Virginia | 15,000.00 | 11,474.68 | 219.76 | 45.93 | 368.86 | 259.11 | 425.95 | 139.53 |
| Wisconsin | 15,000.00 | 8,470.00 | 1,655.97 | ........ | 373.21 | 48.32 | 54.50 | 571.68 |
| Wyoming | 15.000.00 | 4,761.65 | 2,981.27 | 973.91 | 396.88 | 386.33 | 1,069.89 | 345.45 |
| Total | 720,000.00 | 409,127.38 | 101,462.66 | 38,432.74 | 12,891.78 | 8,860.04 | 12,859.21 | 10,252.50 |

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[a] The expenditures under the different heads are affected

*appropriation for year ended June 30, 1904.*[a]

| Itemized. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Seeds, plants, and sundry supplies. | Fertilizers. | Feeding stuffs. | Library. | Tools, implements, and machinery. | Furniture and fixtures. | Scientific apparatus. | Live stock. | Traveling expenses. | Contingent expenses. | Buildings and repairs. | Balance. |
| $921.03 | $332.02 | $144.95 | $528.60 | $139.70 | $46.10 | $577.09 | $22.55 | $36.51 | $16.43 | $560.87 | .......... |
| 225.02 | 471.77 | 192.99 | 5.12 | 387.68 | 79.27 | 97.20 | 9.50 | 564.30 | 40.82 | 513.71 | .......... |
| 874.29 | .......... | 129.05 | 39.45 | .......... | 12.00 | 27.16 | 9.00 | 460.14 | 62.10 | 726.15 | $1,836.55 |
| 492.40 | 2.30 | 281.56 | 21.94 | 91.12 | 66.45 | 70.50 | 251.50 | 873.89 | .......... | 255.76 | .......... |
| 52.65 | 5.00 | .......... | 75.28 | .......... | .70 | 455.01 | .......... | 1,006.35 | 26.00 | .......... | .......... |
| .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| 300.19 | .......... | 132.73 | 5.95 | 180.73 | 85.25 | 482.74 | 434.92 | 304.63 | 60.00 | 23.25 | .......... |
| 407.40 | 24.67 | 49.89 | 469.63 | 32.64 | 115.60 | 357.23 | 24.05 | 634.57 | 89.35 | 657.22 | .......... |
| 370.32 | 127.85 | 159.30 | 164.13 | 142.43 | 15.98 | 975.87 | 389.33 | 409.95 | 15.10 | 749.90 | .......... |
| 382.21 | 406.23 | 911.82 | 48.52 | 151.82 | 9.50 | .......... | .......... | 142.52 | 49.85 | 750.00 | .......... |
| 264.08 | .......... | 809.60 | 108.67 | 317.17 | 56.55 | 445.38 | 42.85 | 554.65 | 83.15 | 429.22 | .......... |
| 692.97 | 11.28 | .......... | 238.69 | 652.73 | 48.73 | 13.16 | .......... | 913.28 | 30.85 | 81.45 | .......... |
| 535.09 | 1.00 | 1,290.65 | 93.46 | 126.52 | 8.00 | .......... | 37.00 | 191.06 | 19.90 | 164.51 | .......... |
| 1,382.97 | .......... | .......... | .......... | 320.33 | 219.10 | .......... | .......... | .......... | 15.00 | 631.67 | .......... |
| 337.20 | .......... | 58.54 | 32.27 | 476.44 | 105.35 | 462.78 | 65.70 | 261.23 | 18.00 | 285.58 | .......... |
| 296.84 | .......... | 64.00 | 474.40 | 43.05 | .......... | 149.56 | .......... | 6.29 | 117.39 | 1.80 | .......... |
| 318.15 | 127.47 | 566.78 | 152.31 | 269.40 | .......... | 14.39 | 33.66 | .......... | .......... | .......... | .......... |
| 572.66 | 240.04 | 685.26 | 265.45 | 291.89 | 186.52 | 172.65 | 117.30 | 262.75 | 28.50 | 750.00 | .......... |
| 600.10 | 256.32 | 387.28 | 298.84 | 615.16 | .......... | 40.62 | 452.00 | 163.83 | 15.00 | 419.03 | .......... |
| 408.19 | 1,331.20 | 401.28 | 31.70 | 221.33 | 509.31 | 318.21 | 313.50 | 137.02 | 10.00 | 301.22 | .......... |
| 819.73 | 27.18 | 99.69 | 293.99 | 46.67 | 80.50 | 490.04 | 1,503.38 | 270.44 | 2.88 | 6.77 | .......... |
| 22.08 | .......... | 932.47 | .......... | 14.03 | 59.00 | .......... | 250.00 | .......... | .......... | .......... | .......... |
| 760.77 | 72.04 | 1,446.41 | 86.13 | 543.88 | 38.45 | .......... | 1,207.29 | 240.51 | 15.00 | 737.59 | .......... |
| 971.66 | 7.70 | 2,474.07 | 96.98 | 25.00 | 117.33 | 101.35 | 1,039.50 | 366.84 | 18.00 | 412.26 | .......... |
| 195.64 | 12.50 | .......... | .......... | 287.97 | 110.81 | 91.01 | .......... | .......... | 15.00 | .......... | .......... |
| 439.38 | .......... | 998.48 | 1.20 | 121.65 | 29.62 | 209.81 | 60.00 | 91.56 | 15.00 | 198.65 | .......... |
| 292.94 | .......... | 17.00 | 3.00 | 1.50 | 97.45 | 39.60 | 695.85 | 444.25 | 15.00 | 128.89 | .......... |
| 264.76 | 220.09 | 162.13 | 173.82 | 266.28 | 188.82 | 515.33 | 78.00 | 178.03 | 22.67 | 228.11 | .......... |
| 138.59 | 60.00 | .......... | 765.13 | .......... | 289.69 | 210.86 | .......... | 155.80 | 223.40 | 374.24 | .......... |
| 920.73 | 40.50 | 517.22 | 2.50 | 693.03 | 176.96 | 49.03 | 234.12 | 509.70 | 102.50 | .......... | .......... |
| 174.81 | 213.66 | .......... | 13.71 | 66.75 | 15.00 | 119.65 | 175.00 | 207.17 | 103.10 | 23.08 | .......... |
| 571.20 | 124.30 | .......... | .......... | .......... | 30.50 | .......... | .......... | 93.19 | 15.00 | 97.06 | .......... |
| .......... | 115.49 | .......... | 46.06 | 70.65 | .......... | 7.50 | .......... | 238.75 | 15.00 | .......... | .......... |
| 172.06 | .......... | 123.98 | .......... | 84.91 | .......... | 51.58 | 654.18 | 200.00 | 39.00 | 25.40 | .......... |
| 519.08 | 286.04 | 377.48 | .......... | 1,105.60 | .......... | .......... | .......... | 70.16 | 15.00 | 119.07 | .......... |
| 379.48 | 1.00 | 667.35 | 79.67 | 283.02 | 31.10 | 95.46 | 570.71 | 501.10 | 15.00 | 750.00 | .......... |
| 294.61 | 30.25 | 377.47 | 80.41 | 351.84 | .......... | .......... | .......... | 334.30 | 33.72 | .......... | .......... |
| 16.35 | 156.00 | 1,325.87 | 237.97 | .......... | 10.50 | 16.67 | 316.13 | 208.32 | 15.00 | 47.96 | .......... |
| 336.42 | 243.14 | 563.70 | 605.04 | 699.37 | 33.02 | 44.14 | 28.35 | 174.69 | 15.00 | 723.43 | .......... |
| 361.82 | 142.46 | 1,041.96 | 60.49 | 330.42 | .......... | 11.00 | .......... | 287.42 | 35.63 | 576.48 | .......... |
| 386.58 | .......... | 304.16 | 11.80 | 188.43 | 266.02 | 357.98 | 219.13 | 165.24 | .......... | 117.89 | .......... |
| 369.48 | 160.55 | 99.60 | 230.72 | 221.50 | 26.25 | 184.99 | .......... | 183.34 | 66.93 | 713.42 | .......... |
| 343.68 | 62.75 | 687.63 | 96.22 | 85.50 | 285.88 | 240.87 | 480.00 | 517.53 | 105.07 | 487.24 | .......... |
| 539.83 | 19.90 | 849.20 | 41.26 | 396.79 | 23.80 | 21.81 | 174.00 | 382.00 | 117.50 | 148.53 | .......... |
| 154.63 | 140.15 | 1,022.40 | 44.59 | 43.90 | 2.19 | 176.97 | 38.63 | 263.31 | 18.25 | 670.47 | .......... |
| 677.08 | 52.38 | .......... | .......... | .......... | .......... | .......... | .......... | 110.00 | 35.00 | 211.83 | .......... |
| 981.86 | .......... | 593.05 | .......... | .......... | 44.65 | .......... | .......... | 257.00 | 15.15 | 471.05 | .......... |
| 86.61 | 46.00 | 246.95 | 286.26 | 288.88 | 10.00 | 814.67 | .......... | 188.91 | 15.00 | 82.90 | .......... |
| 1,086.67 | 20.15 | 46.20 | 542.06 | 25.00 | 57.00 | 497.96 | 379.07 | 407.21 | 15.00 | 750.00 | .......... |
| 312.25 | .......... | 842.09 | 285.08 | 124.75 | 269.63 | 205.80 | 1,046.80 | 661.52 | 27.00 | 309.70 | .......... |
| 22,024.54 | 5,591.38 | 22,082.19 | 7,138.50 | 10,827.51 | 3,858.58 | 9,213.63 | 11,353.00 | 14,631.26 | 1,843.24 | 15,713.31 | 1,836.55 |

by the total revenue of the station, as shown in Table 9.

TABLE 11.—*Disbursements from the United States Treasury to the States and Territories*

| State or Territory. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. |
|---|---|---|---|---|---|---|---|---|
| Alabama | $11,250.00 | $18,750.00 | $14,999.34 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 |
| Arizona | .......... | .......... | 10,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Arkansas | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| California | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Colorado | 11,250.60 | 18,713.24 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Connecticut | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Dakota (Territory) | 11,250.00 | 18,750.00 | 15,000.00 | 11,250.00 | .......... | .......... | .......... | .......... |
| Delaware | 11,250.00 | 18,188.84 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Florida | 11,250.00 | 18,750.00 | 14,998.05 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Georgia | 11,250.00 | 18,733.55 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Idaho | .......... | .......... | .......... | .......... | .......... | 15,000.00 | 15,000.00 | 15,000.00 |
| Illinois | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Indiana | 11,250.00 | 18,662.91 | 14,988.28 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Iowa | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Kansas | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,900.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Kentucky | 11,350.00 | 18,746.57 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Louisiana | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Maine | 11,250.00 | 18,750.00 | 14,999.75 | 14,999.87 | 15,000.00 | 15,000.00 | 15,000.00 | 13,000.00 |
| Maryland | 11,250.00 | 18,725.28 | 14,998.65 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Massachusetts | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Michigan | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Minnesota | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Mississippi | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Missouri | 11,250.00 | 13,391.66 | 15,455.58 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Montana | .......... | .......... | .......... | .......... | .......... | .......... | 15,000.00 | 15,000.00 |
| Nebraska | 11,250.00 | 18,750.00 | 15,000.00 | 14,999.87 | 15,000.00 | 14,951.00 | 14,981.21 | 15,000.00 |
| Nevada | 11,250.00 | 18,750.00 | 14,951.39 | 15,000.00 | 14,999.44 | 15,000.00 | 15,000.00 | 15,000.00 |
| New Hampshire | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,090.00 | 15,000.00 | 15,000.00 |
| New Jersey | 11,250.00 | 18,711.97 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| New Mexico | .......... | .......... | 10,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| New York | 11,250.00 | 18,708.09 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| North Carolina | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| North Dakota | .......... | .......... | .......... | 17,500.00 | 15,000.00 | 15,000.00 | 14,830.62 | 15,000.00 |
| Ohio | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Oklahoma | .......... | .......... | .......... | .......... | 15,000.00 | 15,000.00 | 15,000.00 | 14,701.00 |
| Oregon | 11,250.00 | 11,250.00 | 9,132.52 | 15,000.00 | 13,791.7[illegible] | 16,207.59 | 15,000.00 | 15,000.00 |
| Pennsylvania | 11,250.00 | 18,717.95 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Rhode Island | .......... | 15,000.00 | 30,000.00 | 15,500.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| South Carolina | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 14,542.1[illegible] | 15,000.00 | 15,000.00 | 15,000.00 |
| South Dakota | .......... | .......... | .......... | 3,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Tennessee | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Texas | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Utah | .......... | .......... | 10,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Vermont | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Virginia | 11,250.00 | 18,742.57 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Washington | .......... | .......... | .......... | .......... | 15,000.00 | 11,250.00 | 18,750.00 | 15,000.00 |
| West Virginia | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Wisconsin | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Wyoming | .......... | .......... | .......... | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| Total | 427,500.00 | 713,792.63 | 624,523.56 | 662,499.74 | 718,333.30 | 702,408.67 | 723,561.83 | 719,701.00 |

[a] This table was prepared in the Treasury for the use of this Depart

*for agricultural experiment stations under the act of Congress approved March 2, 1887.*[a]

| 1896. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. |
|---|---|---|---|---|---|---|---|---|
| $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 | $15,000.00 |
| 14,816.71 | 14,987.09 | 14,999.35 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 14,999.67 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 14,970.36 | 14,998.07 | 14,999.63 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 14,998.47 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 14,988.49 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,900.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 14,998.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 14,987.18 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 14,969.30 | 14,601.43 | 15,000.00 | 14,999.07 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 11,250.00 | 18,750.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 14,500.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.50 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 16,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 14,969.72 | 14,999.50 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 | 15,000.00 |
| 719,803.89 | 716,199.86 | 723,321.14 | 719,986.56 | 719,998.70 | 719,998.90 | 719,469.72 | 719,999.50 | 719,999.67 |

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ment by the courtesy of the honorable Secretary of the Treasury.

# FEDERAL LEGISLATION, REGULATIONS, AND RULINGS AFFECTING AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

## FEDERAL LEGISLATION.

### ACT OF 1862 DONATING LANDS FOR AGRICULTURAL COLLEGES.

AN ACT Donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That there be granted to the several States, for the purposes hereinafter mentioned, an amount of public land, to be apportioned to each State a quantity equal to thirty thousand acres for each Senator and Representative in Congress to which the States are respectively entitled by the apportionment under the census of eighteen hundred and sixty: *Provided,* That no mineral lands shall be selected or purchased under the provisions of this act.

SEC. 2. That the land aforesaid, after being surveyed, shall be apportioned to the several States in sections or subdivisions of sections, not less than one-quarter of a section; and whenever there are public lands in a State subject to sale at private entry at one dollar and twenty-five cents per acre, the quantity to which said State shall be entitled shall be selected from such lands within the limits of such State, and the Secretary of the Interior is hereby directed to issue to each of the States in which there is not the quantity of public lands subject to sale at private entry at one dollar and twenty-five cents per acre to which said State may be entitled under the provisions of this act land scrip to the amount in acres for the deficiency of its distributive share; said scrip to be sold by said States and the proceeds thereof applied to the uses and purposes prescribed in this act and for no other use or purpose whatsoever: *Provided,* That in no case shall any State to which land scrip may thus be issued be allowed to locate the same within the limits of any other State or of any Territory of the United States, but their assignees may thus locate said land scrip upon any of the unappropriated lands of the United States subject to sale at private entry at one dollar and twenty-five cents, or less, per acre: *And provided further,* That not more than one million acres shall be located by such assignees in any one of the States: *And provided further,* That no such location shall be made before one year from the passage of this act.

SEC. 3. That all the expenses of management, superintendence, and taxes from date of selection of said lands, previous to their sales, and all expenses incurred in the management and disbursement of the moneys which may be received therefrom, shall be paid by the States to which they may belong, out of the treasury of said States, so that the entire proceeds of the sale of said lands shall be applied without any diminution whatever to the purposes hereinafter mentioned.

SEC. 4. That all moneys derived from the sale of the lands aforesaid by the States to which the lands are apportioned, and from the sales of land scrip hereinbefore provided for, shall be invested in stocks of the United States, or of the States, or some other safe stocks, yielding not less than five per centum upon the par value of said stocks; and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished (except so far as may be provided in section fifth of this act), and the interest of which shall be inviolably appropriated, by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

SEC. 5. That the grant of land and land scrip hereby authorized shall be made on the following conditions, to which, as well as to the provisions hereinbefore contained, the previous assent of the several States shall be signified by legislative acts:

First. If any portion of the fund invested, as provided by the foregoing section, or any portion of the interest thereon, shall, by any action or contingency, be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished; and the annual interest shall be regularly applied without diminution to the purposes mentioned in the fourth section of this act, except that a sum, not exceeding ten per centum upon the amount received by any State under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms whenever authorized by the respective legislatures of said States.

Second. No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings.

Third. Any State which may take and claim the benefit of the provisions of this act shall provide, within five years, at least not less than one college, as described in the fourth section of this act, or the grant to such State shall cease; and said State shall be bound to pay the United States the amount received of any lands previously sold and that the title to purchasers under the State shall be valid.

Fourth. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results and such other matters, including State industrial and economical statistics, as may be supposed useful, one copy of which shall be transmitted by mail free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.

Fifth. When lands shall be selected from those which have been raised to double the minimum price, in consequence of railroad grants, they shall be computed to the State at the maximum price and the number of acres proportionately diminished.

Sixth. No State while in a condition of rebellion or insurrection against the Government of the United States shall be entitled to the benefit of this act.

Seventh. No State shall be entitled to the benefits of this act unless it shall express its acceptance thereof by its legislature within two years from the date of its approval by the President.

SEC. 6. That land scrip issued under the provisions of this act shall not be subject to location until after the first day of January, one thousand eight hundred and sixty-three.

SEC. 7. That the land officers shall receive the same fees for locating land scrip issued under the provisions of this act as is now allowed for the location of military bounty land warrants under existing laws: *Provided*, Their maximum compensation shall not be thereby increased.

SEC. 8. That the governors of the several States to which scrip shall be issued under this act shall be required to report annually to Congress all sales made of such scrip until the whole shall be disposed of, the amount received for the same, and what appropriation has been made of the proceeds.

Approved, July 2, 1862.

## ACT OF 1866 EXTENDING THE TIME WITHIN WHICH AGRICULTURAL COLLEGES MAY BE ESTABLISHED.

AN ACT To amend the fifth section of an act entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," approved July 2, 1862, so as to extend the time within which the provisions of said act shall be accepted and such colleges established.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the time in which the several States may comply with the provisions of the act of July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," is hereby extended so that the acceptance of the benefits of the said act may be expressed within three years from the passage of this act, and the colleges required by the said act may be provided within five years from the date of the filing of such acceptance with the Commissioner of the General Land Office: *Provided*, That when any Territory shall become a State and be admitted into the Union, such new State shall be entitled to the benefits of the said act of July second, eighteen hundred and sixty-two, by expressing the acceptance therein required within three years from the date of its admission into the Union, and providing the college or colleges within five years after such acceptance, as prescribed in this act: *Provided further*, That any State which has heretofore expressed its acceptance of the act herein referred to shall have the period of five years within which to provide at least one college, as described in the fourth section of said act, after the time for providing said college, according to the act of July second, eighteen hundred and sixty-two, shall have expired.

Approved, July 23, 1866.

## ACT OF 1887 ESTABLISHING AGRICULTURAL EXPERIMENT STATIONS.

AN ACT To establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided*, That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies of the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under the varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner [now Secretary] of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important, and, in general, to furnish such advice and assistance as will best promote the purpose of this act. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner [now Secretary] of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such States shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have established, under the provisions of said act of July second aforesaid, an agricultural department or experimental station in connection with any university, college, or institution not distinctly an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school, and no legislature shall by contract, express or implied, disable itself from so doing.

SEC. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

## ACT OF 1890 FOR THE FURTHER ENDOWMENT OF ARICULTURAL COLLEGES.

AN ACT To apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts established under the provisions of an act of Congress approved July second, eighteen hundred and sixty-two.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided, to each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars, to be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life and to the facilities for such instruction: *Provided*, That no money shall be paid out under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students, but the establishment and maintenance of such college separately for white and colored students shall be held to be a compliance with the provisions of this act if the funds received in such State or Territory be equitably divided as hereinafter set forth: *Provided*, That in any State in which there has been one college established in pursuance of the act of July second, eighteen hundred and sixty-two, and also in which an educational institution of like character has been established, or may be hereafter established, and is now aided by such State from its own revenue, for the education of colored students in agriculture and the mechanic arts, however named or styled, or whether or not it has received money heretofore under the act to which this act is an amendment, the legislature of such State may propose and report to the Secretary of the Interior a just and equitable division of the fund to be received under this act, between one college for white students and one institution for colored students, established as aforesaid, which shall be divided into two parts, and paid accordingly, and thereupon such institution for colored students shall be entitled to the benefits of this act and subject to its provisions, as much as it would have been if it had been included under the act of eighteen hundred and sixty-two, and the fulfillment of the foregoing provisions shall be taken as a compliance with the provisions in reference to separate colleges for white and colored students.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the Secretary of the Treasury, upon the warrant of the Secretary of the Interior, out of the Treasury of the United States, to the State or Territorial treasurer, or to such officer as shall be designated by the laws of such State or Territory to receive the same, who shall, upon the order of the trustees of the college or the institution for colored students, immediately pay over said sums to the treasurers of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the Secretary of Agriculture and to the Secretary of the Interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of the State or Territory for the further and more complete endowment, support, and maintenance of colleges, or of institutions for colored students, as provided in this act, shall, by any action or contingency, be diminished or lost, or be misapplied, it shall be replaced by the State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings. An annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their costs and results and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

SEC. 4 That on or before the first day of July in each year, after the passage of this act, the Secretary of the Interior shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is entitled to receive its share of the annual appropriation for colleges, or of institutions for colored students, under this act, and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of the Interior shall withhold a certificate from any State or Territory of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress, in order that the State or Territory may, if it should so desire, appeal to Congress from the determination of the Secretary of the Interior. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury. And the Secretary of the Interior is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of the Interior shall annually report to Congress the disbursements which have been made in all the States and Territories, and also whether the appropriation of any State or Territory has been withheld, and, if so, the reasons therefor.

SEC. 6. Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, August 30, 1890.

## EXTRACT FROM AN ACT MAKING APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR ENDING JUNE 30, 1904.

AGRICULTURAL EXPERIMENT STATIONS: To carry into effect the provisions of an act approved March second, eighteen hundred and eighty-seven, entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto," and to enforce the execution thereof, eight hundred and ten thousand dollars; forty thousand dollars of which sum shall be payable upon the order of the Secretary of Agriculture to enable him to carry out the provisions of section three of said act of March second, eighteen hundred and eighty-seven, and fifteen thousand dollars of which sum may be expended by the Secretary of Agriculture to investigate and report to Congress upon the agricultural resources and capabilities of Alaska, and to etablish and maintain agricultural experiment stations in said Territory, including the erection of buildings and all other expenses essential to the maintenance of such stations; and the Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of said act of March second, eighteen hundred and eighty-seven; shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of said act, and shall make report thereon to Congress; and the Secretary of Agriculture is hereby authorized to employ such assistants, clerks, and other persons as he may deem necessary in the city of Washington and elsewhere, and to incur such other expenses for office fixtures and supplies, stationery, traveling, freight, and express charges, illustration of the Experiment Station Record, bulletins and reports, as he may find essential in carrying out the objects of the above acts, and the sums apportioned to the several States shall be paid quarterly in advance. And the Secretary of Agriculture is hereby authorized to furnish to such institutions or individuals as may care to buy them copies of the card index of agricultural literature prepared by the Office of Experiment Stations, and charge for the same a price covering the additional expense involved in the preparation of these copies, and he is hereby authorized to apply the moneys received toward the expense of the preparation of the index. And the Secretary of Agriculture is hereby authorized to expend fifteen thousand dollars of which sum to establish and maintain an agricultural station in the Hawaiian Islands, including the erection of buildings, the printing (in the Hawaiian Islands), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station. And the Secretary of Agriculture is hereby authorized to expend fifteen thousand dollars of which sum to establish and maintain an agricultural experiment station in Porto Rico, including the erection of buildings, the printing (in Porto Rico), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station; and the Secretary of Agriculture is authorized to sell such products as are obtained on the land belonging to the agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and to apply the moneys received from the sale of such products to the maintenance of said stations; in all, eight hundred and ten thousand dollars: *Provided*, That five thousand dollars of this sum shall be used by the Secretary of Agriculture to investigate and report upon the organization and progress of farmers' institutes in the several States and Territories and upon similar organizations in foreign countries, with special suggestions of plans and methods for making such organizations more effective for the dissemination of the results of the work of the Department of Agriculture and the agricultural experiment stations and of improved methods of agricultural practice.

Total for agricultural experiment stations, eight hundred and ten thousand dollars.

NUTRITION INVESTIGATIONS: To enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food, with special suggestions of full, wholesome, and edible rations less wasteful and more economical than those in common use, including special investigations on the nutritive value and economy of the diet in public institutions; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories, and as may be mutually agreed upon; and the Secretary of Agriculture is hereby authorized to require said stations to report to him the results of any such investigations which they may carry out, whether in cooperation with said Secretary of Agriculture or otherwise, twenty thousand dollars.

IRRIGATION INVESTIGATIONS: To enable the Secretary of Agriculture to investigate and report upon the laws as affecting irrigation and the rights of riparian proprietors and institutions relating to irrigation and upon the use of irrigation waters, at home or abroad, with especial suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use, and upon plans for the removal of seepage and surplus waters by drainage, and upon the use of different kinds of power for irrigation and other agricultural purposes, and for the preparation, printing, and illustration of reports and bulletins on irrigation, including employment of labor in the city of Washington or elsewhere; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories as may be mutually agreed upon, and all necessary expenses, sixty-five thousand dollars.

PUBLIC ROAD INQUIRIES: To enable the Secretary of Agriculture to make inquiries in regard to the system of road management throughout the United States; to make investigations in regard to the best methods of road making, and the best kind of road-making materials in the several States; the employment of local and special agents, clerks, assistants, and other labor required in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the results of such experiments; to enable the Secretary of Agriculture to investigate the chemical and physical character of road materials, for the pay of experts, chemists, and laborers, for necessary office fixtures, supplies, apparatus, and materials; telegraph and telephone service, traveling, and other necessary expenses, and for preparing and publishing bulletins and reports on this subject for distribution, and to enable him to assist the agricultural colleges and experiment stations in disseminating information on this subject, thirty-five thousand dollars, three thousand dollars of which sum shall be immediately available. * * *

BUREAU OF PLANT INDUSTRY; VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS: Investigating the nature of diseases injurious to fruits, fruit trees, grain, cotton, vegetable, and other useful plants; experiments in the treatment of the same; the study of plant physiology in relation to crop production and the improvement of crops by breeding and selection; to investigate the diseases affecting citrus fruits, pineapples, and truck crops grown during the winter in the Southern States; to investigate canaigre and other tannin-bearing plants; to investigate and report upon the diseases affecting plants on the Pacific coast; to originate or introduce improved varieties of fruits and vegetables in cooperation with the section of seed and plant introduction; to study the relation of soil and climatic conditions to diseases of plants, particularly with reference to the California vine diseases and diseases of the sugar beet, in cooperation with the Bureau of Soils, and for other purposes connected with the discovery and practical application of improved methods of crop production; to continue the work of originating, by breeding and selection, in cooperation with the other divisions of the Department and the experiment stations, new varieties of oranges, lemons, and other tropical and subtropical fruits more resistant to cold and disease and of better quality; varieties of wheat and other cereals more resistant to rust and smut and better suited to the various sections of this country; varieties of cotton more resistant to disease and of longer and better staple, and varieties of pears and apples more resistant to blight and better adapted for export; to investigate the causes of decay in forest timber and timber used for construction purposes, and to devise means for preventing the decay of the same; to investigate the practical application in agriculture of the fixation of atmospheric nitrogen by bacteria and other micro-organisms in soils and in the root tubercles of leguminous and other plants; to cultivate and distribute these nitrogen fixers and to determine the conditions most favorable to their development; to study and find methods for preventing the algal and other contaminations of water supplies; the employment of investigators, local and special agents, clerks, assistants, and student scientific aids at an annual salary of four hundred and eighty dollars each, and other labor required in conducting experiments in the city of Washington and elsewhere, and collating, digesting, reporting, and illustrating the results of such experiments; for telegraph and telephone service; for gas and electric current; purchase of chemicals and apparatus required in the field and laboratory; necessary traveling expenses; for express and freight charges; the preparation of reports and illustrations; the rent and repairs of a building, not to exceed three thousand dollars per annum; all necessary office fixtures and supplies, and for other expenses connected with the practical work of the investigations, one hundred and thirty thousand dollars, five thousand dollars of which sum shall be immediately available.

POMOLOGICAL INVESTIGATIONS: Investigating, collecting, and disseminating information relating to the fruit industry; the collection and distribution of seeds, shrubs, trees, and specimens; and for collecting and modeling fruits, vegetables, and other plants, and furnishing duplicate models to the experiment stations of the several States, as far as found practicable; the employment of investigators, local and special agents, clerks, assistants, student scientific aids at an annual salary of four hundred and eighty dollars each, and other labor required in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the results of such experiments; for gas and electric current; for telegraph and telephone services; for express and freight charges; for all necessary office fixtures and supplies and for traveling and other necessary expenses, to continue the investigations and experiments in the introduction of the culture of European table grapes and the study of the diseases that affect them, for the purpose of discovering remedies therefor, this work to be done in cooperation with the section of seed and plant introduction; to investigate in cooperation with the other divisions and bureaus of the Department and the experiment stations of the several States the market conditions affecting the fruit and vegetable trade in the United States and foreign countries, and the methods of harvesting, packing, storing, and shipping fruit and vegetables, and for experimental shipments of fruits and vegetables to foreign countries, for the purpose of increasing the exportation of American fruits and vegetables, and for all necessary expenses connected with the practical work of the same, and such fruits and vegetables as are needed for these investigations and experimental shipments may be bought in open market and disposed of at the discretion of the Secretary of Agriculture, and he is authorized to apply the moneys received from the sales of such fruits and vegetables toward the continuation and repetition of these investigations and experimental shipments; to investigate, map, and report upon the commercial fruit districts of the United States, for the purpose of determining the relative adaptability of the several important fruits thereto, by a study of the conditions of soil and climate, and of the prevalence of plant diseases existing therein as related to commercial fruit production, thirty-seven thousand dollars, five thousand dollars of which sum may, in the discretion of the Secretary, be expended in cooperation with the experiment station of the State of California for studying the nature of the phylloxera, Anaheim, and other diseases of vines, and for ascertaining the best means for protecting vineyards against their ravages.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS: Investigations relating to medicinal, poisonous, fiber, and other economic plants, seeds, and weeds; the collection of plants, traveling expenses, and express and freight charges; for all necessary office fixtures; the purchase of paper and all other necessary supplies, materials, and apparatus; for rent and ordinary repairs of a building for office and laboratory purposes, not to exceed three thousand dollars; for gas and electric current; for telegraph and telephone service; for the employment of investigators, local and special agents, clerks, assistants, and student scientific aids at an annual salary of four hundred and eighty dollars each, and other labor in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the result of such experiments; subscriptions to and purchase of botanical publications for use in the division; and the preparation, illustration, and publication of reports; to investigate and publish reports upon the useful plants and plant cultures of the tropical territory of the United States, and to investigate, report upon, and introduce other plants promising to be valuable for the tropical territory of the United States, such plants and botanical and agricultural information when secured to be made available for the work of agricultural experiment stations and schools; to investigate the varieties of cereals grown in the United States or suitable for introduction, in order to standardize the naming of varieties as a basis for the experimental work of the State experiment stations, and as an assistance in commercial grading, and to investigate, in cooperation with the Bureau of Chemistry, the cause of deterioration of export grain, particularly in oceanic transit, and devise means of preventing losses from those causes, sixty-five thousand dollars.

GRASS AND FORAGE-PLANT INVESTIGATIONS: To enable the Secretary of Agriculture to conduct investigations of grasses, forage plants, and animal foods in cooperation with other divisions of the Department; to collect and purchase seeds, roots, and specimens of valuable economic grasses and forage plants for investigation; experimental cultivation and distribution, and for experiments and reports upon the best methods of extirpating Johnson and other noxious and destructive grasses; to purchase tools, all necessary office fixtures, materials, apparatus, and supplies; to pay freight, express charges, and traveling expenses; for telegraph and telephone service; for gas and electric currents; for the employment of local and special agents, clerks, assistants, and scientific student aids at an annual salary of four hundred and eighty dollars each, and other labor required in conducting experiments in the city of Washington and elsewhere; rent and repairs of a building not to exceed one thousand two hundred dollars per annum; to prepare drawings and illustrations for circulars, reports, and bulletins; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in establishing and maintaining experimental grass stations, for determining the best methods of caring for and improving meadows and grazing lands, the use of different grasses and forage plants, and their adaptability to various soils and climates, the best native and foreign species for reclaiming overstocked ranges and pastures, for renovating worn-out lands, for binding drifting sands and washed lands, and for turfing lawns and pleasure grounds, and for solving the various forage problems presented in the several sections of our country, thirty-five thousand dollars. * * *

PURCHASE AND DISTRIBUTION OF VALUABLE SEEDS: For the purchase, propagation, testing, and distribution of valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants; for rent of building, not to exceed three thousand dollars; the employment of local and special agents, clerks, assistants, and other labor required, in the city of Washington and elsewhere; all necessary office fixtures and supplies, fuel, transporation, paper, twine, gum, printing, postal cards, gas, and electric current; traveling expenses, and all necessary material and repairs for putting up and distributing the same, and to be distributed in localities adapted to their culture, two hundred and ninety thousand dollars, of which amount not more than forty-eight thousand dollars shall be expended for labor in the city of Washington, District of Columbia, and not less than two hundred and ten thousand dollars shall be allotted for Congressional distribution. * * * *Provided further*, That thirty thousand dollars of the sum thus appropriated, or so much thereof as the Secretary of Agriculture shall direct, may be used to collect, purchase, test, propagate, and distribute rare and valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants from foreign countries for experiments with reference to their introduction into this country; and the seeds, bulbs, trees, shrubs, vines, cuttings, and plants thus collected, purchased, tested, and propagated shall not be included in general distribution, but shall be used for experimental tests to be carried on with the cooperation of the agricultural experiment stations.

BUREAU OF CHEMISTRY: * * * To study, in collaboration with the Weather Bureau and agricultural experiment stations, the influence of environment upon the chemical composition of wheat and other cereals, with especial reference to the variation in the content of gluten and the suitability of barley for brewing and other purposes.

To investigate the chemical composition of sugar-producing plants in the United States and its possessions, and, in collaboration with the Weather Bureau and agricultural experiment stations, to study the effects of environment upon the chemical composition of sugar-producing plants, especially with reference to their content of available sugar, seventy thousand five hundred dollars: *Provided*, That fifteen thousand dollars thereof shall be used exclusively for the purpose of investigating, determining, and reporting the proper treatment and process in order to secure uniform grade and quality of first-class table sirup, of which sum ten thousand dollars shall be immediately available: *Provided*, That if found necessary, twelve hundred dollars of the amount hereby appropriated may be used for the purchase and installment of a new boiler in the Bureau of Chemistry.

## REGULATIONS OF THE POST-OFFICE DEPARTMENT CONCERNING AGRICULTURAL EXPERIMENT STATION PUBLICATIONS.

Section 372 of the Postal Laws and Regulations of the United States reads as follows: Regulations for free transmission of bulletins and reports [under the act of Congress of March 2, 1887] are prescribed as follows:

(1) Any claimant of the privilege must apply for authority to exercise it to the Postmaster-General, stating the date of the establishment of such station, its proper name or designation, its official organization, and the names of its officers; the name of the university, college, school, or institution to which it is attached, if any, the legislation of the State or Territory providing for its establishment, and any other granting it the benefits of the provision made by Congress as aforesaid (accompanied by a copy of the act or acts), and whether any other such station in the same State or Territory is considered, or claims to be, also entitled to the privilege; and also the place of its location and the name of the post-office where the bulletins and reports will be mailed. The application must be signed by the officer in charge of the station.

(2) If such application be allowed after examination by the Department, the postmaster at the proper office will be instructed to admit such bulletins and reports to the mails in compliance with these regulations, and the officer in charge of the station will be notified thereof.

(3) Only such bulletins or reports as shall have been issued after the station became entitled to the benefits of the act can be transmitted free, and such

bulletins or reports may be inclosed in envelopes or wrappers, sealed or unsealed. On the exterior of every envelope, wrapper, or package must be written or printed the name of the station and place of its location, the designation of the inclosed bulletin or report, and the word "Free" over the signature or facsimile thereof, of the officer in charge of the station, to be affixed by himself or by some one duly deputed by him for that purpose. There may also be written or printed upon the envelope or wrapper a request that the postmaster at the office of delivery will notify the mailing station of the change of address of the addressee, or other reason for inability to deliver the same, and upon a bulk package a request to the postmaster to open and distribute the "franked" matter therein in accordance with the address thereon.

Bulletins published by the United States Department of Agriculture and analogous to those of the station, and entitled to be mailed free under the penalty envelope of that Department, may also be adopted and mailed by the several stations, with their own publications, under the same regulations, and any bulletins or reports mailable free by any agricultural experiment station under these regulations may be so mailed by any other station having free-mailing authority.

If such station's annual reports be printed by State authority, and consist in part of matter relating to the land-grant college to which such station is attached, then said report may be mailed free entire by the director of the station; provided, in his judgment, the whole consists of useful information of an agricultural character.

(4) The bulletins may be mailed to the stations, newspapers, or persons to whom they are by the foregoing act authorized to be sent, and the annual reports to any address within the United States, Canada, Mexico, or Hawaiian Kingdom (Sandwich Islands), but not to other foreign countries, free of postage.

An order of the Postmaster-General dated January 3, 1899, provides "That any article entitled to transmission free of postage in the domestic mails of the United States, either in a 'penalty' envelope or under a duly authorized 'frank,' shall be entitled likewise to transmission by mail free of postage between places in Hawaii, Cuba, Porto Rico, and the Philippine Islands; from the United States to those islands, and from those islands to the United States."

Among rulings on matters of detail the following are the most important:

"In sending out bulletins from an agricultural experiment station it is permissible to inclose postal cards to enable correspondents of the station to acknowledge the receipt of its publications and to request their continuous transmission.

"Copies of the reports or bulletins of the agricultural experiment stations, which are purchased, paid, or subscribed for, or otherwise disposed of for gain, when sent in the mails, are not entitled to free carriage under the 'frank' of the director of the station."

Station bulletins and reports, consisting of typewritten matter duplicated on a mimeograph or other duplicating machine, "retain their character as free matter when properly franked by the director of the station."

Cards upon which are printed bulletins issued by agricultural experiment stations established under the provisions of the act of March 2, 1887, may be sent openly in the mails, free of postage, provided the address side of such cards bears the indicia prescribed in paragraph 3, section 517, Postal Laws and Regulations, for envelopes used by the experiment stations referred to in mailing copies of their bulletins and reports.

Reports of State boards of agriculture or other State boards, commissioners, or officers, even though they contain station bulletins and reports, can not be sent free through the mails under the frank of the director of the station.

The catalogue of the college of which the station is a department can not be sent free through the mails under the frank of the director of the station, whether said catalogue is published separately or is bound together with a station publication.

## RULINGS OF THE TREASURY DEPARTMENT AFFECTING AGRICULTURAL EXPERIMENT STATIONS.

From copies of letters addressed to the Secretary of the Treasury and others by the First Comptroller of the Treasury, relating to the construction of the act of Congress of March 2, 1887, and acts supplementary thereto, the following digest has been prepared for the use of the stations. The sections are those of the act, the dates those of the decisions by the Comptroller:

### SECTION 3—JANUARY 30, 1888.

That the annual financial statement of the stations, with vouchers, should not be sent to the Treasury Department, but that a copy simply of the report that is made to the governor is to be sent to the Secretary of the Treasury.

### SECTION 3—JANUARY 31, 1888.

First. That the Treasury Department will not require officers of experiment stations to do or perform anything not specifically required by said bill.

Second. That the Secretary of the Treasury is not required to take a bond of the officers of said stations for the money paid over under the provisions of said act.

Third. That no reports will be required from the stations directly to the Secretary of the Treasury; but the governor of the State must send to the Secretary of the Treasury a copy of the report made to him by the colleges or stations.

### SECTION 4—DECEMBER 16, 1895.

The Solicitor of the Treasury writes: "I am of the opinion that there is no authority for an agricultural experiment station to sell its bulletins outside of the State or Territory. Congress appropriates for the publication and free distribution of the bulletins, and neither expressly nor by necessary implication authorizes their sale."

### SECTION 6—AUGUST 2, 1888.

The fiscal year commences on the 1st day of July, corresponding with the fiscal year of the Government.

An agricultural station entitled to the benefits of said appropriations made by Congress can anticipate the payment to be made July 1, and make contracts of purchases prior to that time, if it shall be necessary to carry on the work of the station. Of course, no portion of said appropriations paid in quarterly installments can be drawn from the Treasury unless needed for the purposes indicated in the act; and so much of what is so drawn as may not have been expended within the year must be accounted for as part of the appropriation for the following year.

### SECTION 8—JANUARY 30, 1888.

The State of New York ought to designate whether to the college or to the station or to both it desires the appropriation to be applied. The eighth section of the act seems to authorize the State to apply such benefits to experimental stations it may have established as it desires.

Where there are no experimental stations connected with the colleges, the legislatures of such States must connect the agricultural experiment station with the colleges already established under the act of July 2, 1862; there is no authority in the act authorizing the establishment of agricultural experiment stations independent of said colleges.

The act contemplates that where stations have already been established disconnected from the colleges, the legislatures of such States may make such provisions in regard thereto as they may deem proper; but it does not authorize the establishment of stations except in connection with the colleges that were at that time or might hereafter be established under the act of July 2, 1862.

### SECTION 8—FEBRUARY 14, 1888.

Where there is an agricultural college or station which may have been established by State authority and is maintained by the State, the eighth section of the above act would authorize the State to designate the station to which it desired the appropriation to be applied, whether to one or more, or all, and the Secretary of the Treasury should make the payment under the appropriation to whichever one the State might desire.

### SECTIONS 1 AND 8—FEBRUARY 15, 1888.

(1) When an agricultural college or station has been established under the act of July 2, 1862, each college is entitled to the benefits of the provisions of said act (i. e., of March 2, 1877).

(2) In a State where an agricultural college has been established under the act of July 2, 1862, and agricultural stations have also been established, either under the act of July 2, 1862, or by State authority, before March 2, 1887, the legislature of such State shall determine which one of said institutions, or how many of them, shall receive the benefits of the act of March 2, 1887.

(3) If the legislature of any State in which an agricultural college has been established under the act of July 2, 1862, desires to establish an agricultural station which shall be entitled to the benefits of said act, it must establish such station in connection with said college.

### PROVISO TO SECTIONS 1 AND 8—DECEMBER 7, 1888.

It is within the power of the legislature of any State that has accepted the provisions of said act of March 2, 1887, to dispose of the amount appropriated by Congress for said station to either one or all of the agricultural colleges or stations which may have been established in said State by virtue of either the provisions of the act of July 2, 1862, or the provisions of said eighth section of the act of March 2, 1887.

The whole responsibility rests upon the State legislature as to how the fund appropriated by Congress shall be distributed among these various institutions of the State, provided there is one or more agricultural colleges with which an agricultural station is connected, or one or more agricultural stations.

## RULINGS OF THE DEPARTMENT OF AGRICULTURE ON THE WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.[a]

In connection with examinations of the work and expenditures of the agricultural experiment stations established in accordance with the act of Congress of March 2, 1887, under authority given to the Secretary of Agriculture by Congress, questions have arisen which have seemed to make it advisable to formulate the views of this Department on certain matters affecting the management of the stations under that act. The statements given below have therefore been prepared to cover the points which seem to require special attention:

### EXPENDITURES FOR PERMANENT SUBSTATIONS.

This Department holds that the expenditure of funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, for the maintenance of permanent substations is contrary to the spirit and intent of said act. The act provides for an experiment station in each State and Territory, which, except in cases specified in the act, is to be a department of the college established under the act of Congress of July 2, 1862. The objects of the stations, as defined in the first-mentioned act, are evidently of such a character as to necessitate the services of scientific and expert workers. Most of the lines of investigation named in the act are general, rather than local, and involve scientific equipment and work. It is obviously the intent that the stations established under this act shall carry on important investigations which shall be of general benefit to the agriculture of the several States and Territories. The sum of $15,000, which is annually appropriated by Congress under this act for each station, is only sufficient to carry out a limited number of investigations of the kind contemplated by the act.

As the work of the stations in the different States has developed, it has been found necessary to limit, rather than expand, the lines of work of the individual stations. Thorough work in a few lines has been found much more effective and productive of more useful results than small investigations in numerous lines. When we consider the nature of the investigations, the amount of money provided for the work of each station, and the fact that the act expressly provides for only a single station in connection with each college, it becomes very clear that expenditures such as are necessary to effectually maintain permanent substations ought not to be made from the funds granted by Congress to the States and Territories for experiment stations. The maintenance of permanent substations, as a rule, involves the erection of buildings and the making of other permanent improvements. The sums of money which can be expended for permanent improvements under the act of Congress aforesaid are so small that it is clear they were not intended to meet the needs of more than one station in each State and Territory.

When the legislature of a State or Territory has given its assent to the provisions of the act of Congress of March 2, 1887, and has designated the institution which shall receive the benefits of said act, it would seem to have exhausted its powers in the matter. The responsibility for the maintenance of an experiment station under said act devolves upon the governing board of the institution thus designated. If the legislature of the State or Territory sees fit to provide funds for the equipment and maintenance of other experiment stations and to put them under the control of the same governing board, well and good, but this does not in any way diminish the responsibility of the board to administer the funds granted by Congress in accordance with the provisions of said act.

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[a] U. S. Dept. Agr., Office of Experiment Stations Circular 29.

The wisdom of Congress in limiting the number of stations to be established in each State and Territory under the aforesaid act has been clearly shown by the experience of the few States and Territories which have attempted the maintenance of substations with the funds granted under said act. The expense of maintaining substations has, as a rule, materially weakened the central station, and the investigations carried on at the substations have been superficial and temporary. It is granted that in many States and Territories more than one agricultural experiment station might do useful work, and in some States more than one station has already been successfully maintained; but in all these cases the State has given funds from its own treasury to supplement those given by Congress. It is also granted that experiment stations established under said act of Congress and having no other funds than those provided by that act will often need to carry on investigations in different localities in their respective States and Territories, but it is held that this should be done in such a way as will secure the thorough supervision of such investigations by the expert officers of the station and that arrangements for such experimental inquiries should not be of so permanent a character as to prevent the station from shifting its work from place to place as circumstances may require, nor involve the expenditure of funds in such amounts and in such ways as will weaken the work of the station as a whole.

As far as practicable, the cooperation of individuals and communities benefited by these special investigations should be sought, and if necessary the aid of the States invoked to carry on enterprises too great to be successfully conducted within the limits of the appropriation granted by Congress under the act aforesaid.

### PURCHASE OR RENTAL OF LANDS FOR AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that the purchase or rental of lands by the experiment stations from the funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, is contrary to the spirit and intent of said act. The act provides for "paying the necessary expenses of conducting investigations and experiments and printing and distributing the results. * * * *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such stations; and thereafter an amount not exceeding 5 per centum of such annual appropriation may be so expended." The only reference to land for the station in the act is in section 8, where State legislatures are authorized to apply appropriations made under said act to separate agricultural colleges or schools established by the State "which shall have connected therewith an experimental farm or station." The strict limitation of the amount provided for buildings and the absence of any provision for the purchase or rental of lands, when taken in connection with the statement in the eighth section, which treats the farm as in a sense a necessary adjunct of the educational institution to which the whole or a part of the funds appropriated in accordance with said act might in certain cases be devoted, point to the conclusion that it was expected that the institution of which the station is a department would supply the land needed for experimental purposes and that charges for the purchase or rental of lands would not be made against the funds provided by Congress for the experiment station. This conclusion is reenforced by consideration of a wise and economic policy in the management of agricultural experiment stations, especially as relating to cases in which it might be desirable for the station to have land for experimental purposes in different localities. The investigations carried on by the stations in such cases being for the direct benefit of agriculture in the localities where the work is done, it seems only reasonable that persons or communities whose interests will be advanced by the station work should contribute the use of the small tracts of land which will be required for experimental purposes. Experience shows that in most cases the stations have had no difficulty in securing such land as they needed, without expense, and it is believed that this may be done in every case without injuriously affecting the interests of the stations.

### EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR CARRYING ON FARM OPERATIONS.

This Department holds that expenses incurred in conducting the operations of farms, whether the farms are connected with institutions established under the act of Congress of July 2, 1862, or not, are not a proper charge against the funds appropriated by Congress for agricultural experiment stations in accordance with the act of Congress of March 2, 1887, unless such operations definitely constitute a part of agricultural investigations or experiments planned and conducted in accordance with the terms of the act aforesaid, under rules and regulations prescribed by the governing board of the station. The performance of ordinary farm operations by an experiment station does not constitute experimental work. Operations of this character by an experiment station should be confined to such as are a necessary part of experimental inquiries. Carrying on a farm for profit or as a model farm, or to secure funds which may be afterwards devoted to the erection of buildings for experiment station purposes, to the further development of experimental investigation, or to any other purpose, however laudable and desirable, is not contemplated by the law as a part of the functions of an agricultural experiment station established under the act of Congress of March 2, 1887. Section 5 of that act plainly limits the expenditures of funds appropriated in accordance with said act to "the necessary expenses of conducting investigations and experiments and printing and distributing the results."

### FUNDS ARISING FROM THE SALE OF FARM PRODUCTS OR OTHER PROPERTY OF AN AGRICULTURAL EXPERIMENT STATION.

This Department holds that moneys received from the sales of farm products or other property in the possession of an agricultural experiment station as the result of expenditures of funds received by the station in accordance with the act of Congress of March 2, 1887, rightfully belong to the experiment station as a department of the college or other institution with which it is connected, and may be expended in accordance with the laws or regulations governing the financial transactions of the governing board of the station, provided, however, that all expenses attending such sales, including those attending the delivery of the property into the possession of the purchaser, should be deducted from the gross receipts from the sales and should not be made a charge against the funds appropriated by Congress.

### LIMIT OF EXPENDITURES OF EXPERIMENT STATIONS DURING ONE FISCAL YEAR.

This Department holds that expenses incurred by an agricultural experiment station in any one fiscal year to be paid from the funds provided under the act of Congress of March 2, 1887, should not exceed the amount appropriated to the station by Congress for that year, and especially that all personal services should be paid for out of the appropriation of the year in which they were performed, and that claims for compensation for such services can not properly be paid out of the appropriations for succeeding years. The several appropriations for experiment stations under the aforesaid act are for one year only, and officers of experiment stations have no authority to contract for expenditures beyond the year for which Congress has made appropriations.

This is plainly implied in the act aforesaid, inasmuch as section 6 provides that unexpended balances shall revert to the Treasury of the United States, "in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support." The annual financial report rendered in the form prescribed by this Department should in every case include only the receipts and expenditures of the fiscal year for which the report is made.

### EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR A WATER SYSTEM TO BE CHARGED UNDER "BUILDINGS AND REPAIRS."

This Department holds that expenditures by agricultural experiment stations from the funds appropriated in accordance with the act of Congress of March 2, 1887, for the construction of wells, cisterns, ponds, or other reservoirs for the storage of water, and for piping, and other materials for a system of storing and distributing water, are properly charged, under abstract 18 in the schedule for financial reports prescribed by this Department, as being for improvements on lands which have hitherto been held to come under the head of "building and repairs." The fact that a water system may be a necessary adjunct of certain experimental inquiries does not affect the case, inasmuch as the limitations on expenditures for improvements contained in section 5 of the act of Congress of March 2, 1887, expressly stipulate that these improvements shall be such as are necessary for carrying on the work of the station.

### EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR MEMBERSHIP IN AGRICULTURAL AND OTHER ORGANIZATIONS.

This Department holds that membership fees in associations and other organizations are not a proper charge against the funds appropriated by Congress in accordance with the act of March 2, 1887, except in the case of the Association of American Agricultural Colleges and Experiment Stations, which is held to be an essential part of the system of experiment stations established under said act.

### THE BORROWING OF MONEY TO PAY THE EXPENSES OF AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that experiment station officers have no authority to borrow money to be repaid out of appropriations made under the act of Congress of March 2, 1887, and that charges for interest can not properly be made against funds appropriated under that act.

A. C. TRUE, *Director.*

Approved:
J. STERLING MORTON, *Secretary.*
WASHINGTON, D. C., *March 10, 1896.*

### THE USE OF EXPERIMENT STATION FUNDS FOR COLLEGE PURPOSES.

This Department holds that no portion of the funds appropriated by Congress in accordance with the act of March 2, 1887, can legally be used, either directly or indirectly, for paying the salaries or wages of professors, teachers, or other persons whose duties are confined to teaching, administration, or other work in connection with the courses of instruction given in the colleges with which the stations are connected or in any other educational institution; nor should any other expenses connected with the work or facilities for instruction in school or college courses be paid from said fund. In case the same persons are employed in both the experiment station and the other departments of the college with which the station is connected a fair and equitable division of salaries or wages should be made, and in case of any other expenditures for the joint benefit of the experiment station and the other departments of the college the aforesaid funds should be charged with only a fair share of such expenditures.

Respectfully, A. C. TRUE, *Director.*

Approved:
JAMES WILSON, *Secretary of Agriculture.*
WASHINGTON, D. C., *October 25, 1897.*

# THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

## OFFICERS.

*President.*

E. B. Voorhees, of New Jersey.

*Vice-Presidents.*

J. C. Hardy, of Mississippi.
C. D. Woods, of Maine.
K. L. Butterfield, of Rhode Island.
E. R. Nichols, of Kansas.
E. Davenport, of Illinois.

*Secretary-Treasurer.*

J. L. Hills, of Vermont.

*Bibliographer.*

A. C. True, of Washington, D. C.

*Executive Committee.*

H. C. White, of Georgia.
W. H. Jordan, of New York.
J. L. Snyder, of Michigan.
C. F. Curtiss, of Iowa.
L. H. Bailey, of New York.

*Sections.*

Section on College Work and Administration: R. W. Stimson, of Connecticut, chairman; K. L. Butterfield, of Rhode Island, secretary.

Section on Experiment Station Work: H. J. Patterson, of Maryland, chairman; M. A. Scovell, of Kentucky, secretary.

## EIGHTEENTH ANNUAL CONVENTION.

### GENERAL SESSION.

The eighteenth annual convention of this association was held in the Chamberlain Hotel, at Des Moines, Iowa, November 1 to 3. It was the first meeting under the new constitution, which reduces the number of sections from five to two, and the advantage of the new plan was very marked in enabling delegates to follow the discussions more closely, and in concentrating the deliberations upon questions relating to the administration of the colleges and stations, their general management and methods of work. The two sections under the present constitution are (1) on college work and administration, and (2) experiment station work.

The general sessions were presided over by Dr. W. O. Thompson, of the University of Ohio, who delivered the customary presidential address. This dealt with Some Problems in the Colleges of Agriculture and Mechanic Arts, and gave special attention to the agricultural phase of their work. Among the problems noted were the conditions in the agricultural communities, the much-discussed tendency away from the farm, and the lack of opportunity which the farmer's boy has for individual initiative. It was urged that farm life must not be the refuge of necessity, that not all farmers' sons are suited to be farmers any more than all lawyers' sons are suited to that profession, and that marked changes in farming have taken place in recent years which call for special aptitude and training quite as much as any other work in life. It was pointed out that intelligent operation of the farm is now necessary for any margin of profit, and the fallacy that unintelligent men can make successful farmers or satisfactory farm laborers was denounced. "We need to know that intelligence on the farm will produce results just as surely as elsewhere," and this leads to the requirement for agricultural education.

Considering first the agricultural colleges, which was the starting point of education in agriculture, it was pointed out that these institutions or departments have been working under the disadvantage of too little money, and that there has been a lack of appreciation that agricultural education must necessarily be a very expensive form of education, calling for extensive equipment which must be maintained at considerable outlay, and other items not commonly met with in laboratory work. A plea was made for the introduction of agriculture into the rural schools, and for an extension department of the college to stimulate interest in agricultural education in the rural communities. The agricultural colleges should furnish the inspiration and initiative for these movements, and there is need of conducting a propaganda in their interests since agriculture differs from other industries in that it will not take care of itself, like banking or engineering. The speaker held that "the problem of agricultural education will not be solved until the agricultural colleges have been brought into close and vital relations to the agricultural populations."

The report of the executive committee, submitted by Dr. H. C. White, chairman, described the efforts of the committee in behalf of the bills for establishing the mining schools at the land-grant colleges, and for the further endowment of the experiment stations, now pending in Congress, and the conferences of the committee with the Secretary of Agriculture and other officials of his Department relative to cooperation between the Department and the experiment stations. The report led to the discussion of the relations of the experiment stations and their work to the Department of Agriculture. In the course of the discussion a resolution, introduced by Dr. W. H. Jordan, of New York, recognized the mutually advantageous relations between the Department and the experiment stations of the several States, but recorded the belief of the association that the continuation and development of these relations and the maintenance and progress of efficient research in agricultural science "demand that the autonomy and paramount position of the stations as institutions of research and experimentation be inviolably maintained within their respective States, in accordance with the terms and spirit of the Hatch Act." The resolution instructed the executive committee to request a hearing before the proper committees of Congress for the purpose of presenting the work and claims of the experiment stations, in order that Congress may be properly informed as to the work of these institutions and its value to agricultural practice; and, furthermore, to continue conferences with the Secretary of Agriculture relative to coöperation between his Department and the stations.

The committee on the collective exhibit of the agricultural colleges and experiment stations at St. Louis, through its chairman, Dr. W. H. Jordan, presented a progress report briefly enumerating some of the features relating to the exhibit.

There was the usual report of the bibliographer, by Dr. A. C. True, and the committee on indexing agricultural literature, both of which enumerated the bibliographies and indexes to agricultural science which had appeared during the year; and the committee on methods of teaching agriculture presented a report on The Teaching of Agriculture in the Rural Schools, with a syllabus of an elementary course in agriculture.

The report of the committee on graduate study reaffirmed the plan of conducting a graduate summer school under the auspices of the association, and recommended that the school be held in future every two years, beginning, if possible, with the coming summer. The committee was empowered to arrange for the holding of such schools, and each agricultural college was requested to make an annual contribution of $25 to aid in their maintenance.

The committee on uniform fertilizer and feeding-stuff laws submitted a brief report through its chairman, Dr. H. J. Wheeler, which dealt in part with the question of nomenclature in reporting the results of analysis; this matter was subsequently referred to a special committee to cooperate with a similar committee of the Association of Official Agricultural Chemists.

The report of the committee on rural engineering, presented by W. E. Stone, chairman, reported the progress which has been made during the year in developing courses in agricultural engineering and farm mechanics. Courses in these subjects are now offered by the agricultural colleges of California, Colorado, Illinois, Indiana, Iowa, Kansas, Minnesota, New York, North Dakota, Wisconsin, and

Wyoming. Some examples of the benefits of instruction and investigation carried on by these departments were presented. The report recognized it as exceedingly important at this time that a bureau or division of agricultural engineering be organized in this Department to aid the colleges which now have courses in agricultural engineering, to collect the data which such colleges are obtaining in their experimental tests, to carry on original research, and to establish laboratories for practical tests of implements, etc.

The committee on animal and plant breeding, through Prof. W. M. Hays, reviewed the activity in research along these lines, and described the formation of the American Breeders' Association.

Resolutions were passed by the association tendering to the Hon. H. C. Adams and Hon. F. W. Mondell the hearty thanks of the association for their earnest, intelligent, and well-directed efforts in behalf of the bill for increasing the appropriation to the experiment stations and the mining bill, and pledging the hearty cooperation and assistance of the association. By another resolution the executive committee was authorized to use its efforts to secure the passage of these bills and to give precedence in this to Mr. Adams's bill.

Resolutions paying an eloquent tribute to the late Maj. Henry E. Alvord, a former president and member of the executive committee of the association, were presented by President James K. Patterson, of Kentucky. These recorded the high esteem and affection in which Major Alvord was held by the association, and testified to his eminent services to agriculture in the various public and private capacities in which he served.

The social phase of agricultural education was discussed in a paper by President Kenyon L. Butterfield, of Rhode Island. He laid down the broad proposition that the agricultural college should serve as a social agency in helping to solve all phases of the rural problem, and pointed out that this was not merely a matter of technic, but a problem of economic, political, and social significance. The present courses of study at the agricultural colleges were shown to deal almost exclusively with the technical phase and the training of the individual to become a highly specialized expert. The introduction of rural economics and the spirit which it stands for was stated to be far more than the adding of two or three subjects of study to the agricultural course, but involved the socializing of the whole spirit and method of the college. The greatest need of American agriculture to-day was declared to be social leadership. It was argued that the college should assume this leadership and should train men and women for the service. A great enlargement of extension work among the farmers was advocated in order to teach the people who can not come to the college.

An address was delivered by Director William Saunders, of the Central Experimental Farm at Ottawa, Canada, on The Upbuilding of Agriculture. This reviewed the development of agricultural education and experimentation in the United States and in Canada, and noted many of the material results of the experimental work in Canada and British Columbia, especially in the introduction and improvement of cereals by selection and breeding.

### SECTION ON COLLEGE WORK AND ADMINISTRATION.

The programme of this section included some of the problems of the liveliest interest to the land-grant colleges, and the discussion served to clarify the views on a number of important points.

The question as to how far the land-grant institutions may or should engage in teaching elementary subjects, not generally recognized as belonging to the collegiate curriculum, was opened by a paper by President W. O. Thompson, who justified bringing the elementary instruction quite low down owing to the lack of proper training in the rural schools, and also commended the short courses. Dr. R. H. Jesse, of Missouri, took the opposite ground and maintained that the remedy for the condition lay in the improvement of the public school system by the introduction of agricultural studies. While this was acknowledged to be the long way, as changes of that sort are slow of realization, he believed it to be the right way, which would justify itself in the long run. He disapproved of the establishment of agricultural high schools or preparatory departments for the agricultural colleges, but thought that the college of agriculture should rest on the public schools. Prof. L. H. Bailey, of Cornell University, took a middle-ground upon the question, holding that while these forms of elementary instruction do not properly belong in the college and are a temporary expediency, they are entirely warranted by the fact that the land-grant colleges do not at present articulate with the common schools. He believed that the final issue would be to prepare the public schools to prepare for the land-grant colleges, as they now prepare for the colleges of arts and sciences, but as this will occupy many years, perhaps a generation, he believed that the pressing problems of to-day must be taken care of, and on that ground defended the short and low grade courses as temporary expedients.

Other speakers presented the local difficulties in confining the instruction to a four-year course, and maintained that the short courses had first aroused genuine interest and confidence in agricultural education, and that the more elementary grades of work did not obscure the college course. It was held that under present conditions there is a large body of young men who are not and can not be prepared to enter the regular college course, and for these young men, who come to the college in increasing numbers, elementary and short courses are demanded.

The discussion of this question was continued in a paper by President J. L. Snyder, of Michigan, upon the subject What Can and Should be Done to Increase the Interest in and Appreciation for the Agricultural Side of Technical Training? President Snyder urged that the courses in agriculture must be technical, and that the agricultural department must have equal advantages in the way of equipment, teaching force, and buildings, with the other departments of the college or university.

Short courses were advocated for those unable to take the longer courses. The speaker described what was done in Michigan to arouse interest in the agricultural work by maintaining close relations with the public schools, advertising the institution in various ways, and running excursions to the college during August, which the past year was visited by about 8,000 people.

Dean Davenport, of the University of Illinois, urged the need of a differentiation of the subject of agriculture, and a larger number of instructors to cover different phases of the subject. Great progress has been made in this direction at a number of the institutions, but there is still difference in this respect between institutions, and in many cases the teaching force is entirely inadequate. He made the point clear that the number of men to be taught should not be the unit in manning the staff of the agricultural department, as it now too often is, but that the true unit should be the subject itself. He pointed out that the University of Illinois now has more teachers in agriculture than it had students five years ago, and that as soon as the number of instructors was doubled the number of students doubled. He expressed the belief that the interest in agriculture on the part of the students was usually about in proportion to the number of instructors in that subject, and that greater differentiation and increased provision for teaching the various branches of agriculture would meet with the same result everywhere that it did at his institution.

A discussion of the degrees which should be given at the completion of the undergraduate courses in agriculture in the land-grant colleges, led by President G. A. Harter, of Delaware, brought out considerable difference of opinion, some contending for the B. S. and B. A. degrees, while others advocated the degrees B. Agr. and B. S. A. for the agricultural students as more definitely expressing the courses which they had pursued.

The question as to the intent and purpose of the Morrill Act in regard to military instruction was introduced in a paper by President M. H. Buckham, of Vermont. The special interest in this subject has grown out of General Order No. 65, issued by the War Department, which prescribes the amount of military instruction which the officers detailed to the land-grant colleges for this duty are expected to require. Some of the institutions have found themselves unable to comply with these requirements, and as a result the details have been withdrawn. President Buckham suggested that less emphasis be placed on the manual and technical branches of military training and more upon the intellectual topics in the military art, since the students at these land-grant colleges "take military tactics as a part of a liberal education, not to fit them to serve as enlisted men." The quite lengthy discussion upon this subject showed that with the general advocacy of the importance of military work called for by the Morrill Act, there was a quite general dissent from the present requirements of the War Department, and the executive committee of the association was finally instructed to present the views of the association to the authorities at Washington.

### SECTION ON EXPERIMENT STATION WORK.

This section considered the general subject of the breeding and improvement of plants and animals, and held a conference on the question of the amount of teaching which it is desirable for station workers to do.

The development of knowledge regarding methods of breeding plants and animals and the working out of some of the underlying principles was presented in a paper by Prof. W. M. Hays, who expressed a strong belief in the importance of systematic work in breeding and its great commercial application.

Dr. T. L. Lyon, of Nebraska, spoke upon improvement in the quality of wheat, describing the methods which he is working out in this line as distinguished from selection for yield alone. Since a high yield and high nitrogen content do not go together, it was pointed out that there is danger in selecting wheat for yield alone that the quality will be injured, and hence it was maintained that the quality should be taken account of in breeding or selecting for yield.

Prof. H. Snyder, of Minnesota, called attention to the difference in value of wheat for various purposes and the lack of standards, and on his motion a standing committee of three was appointed on standards for determining the value of cereals.

In a paper on Animal Breeding, Prof. C. F. Curtiss, of Iowa, reviewed the work which is now being undertaken in animal breeding at the experiment stations of this country, and made some suggestions for work in that line.

In the conference upon the subject of How much teaching, if any, is it desirable that a station worker should do? there was a lively discussion and a free expression of opinion which seemed to be very largely in one direction. In opening the discussion Dr. H. P. Armsby, of Pennsylvania, showed that according to the latest statistics about 54 per cent of the experiment station workers now do more or less teaching in the agricultural colleges, and that the tendency seemed to be toward an increase. He expressed doubt as to the advantage, which is frequently urged, to the station man of doing college work, and he held that at all events the amount should be small and of advanced character. He believed that in this agricultural work a man should be chiefly either a teacher or an investigator, and maintained that the two kinds of work called for a different attitude of mind and the use of a different set of faculties to a certain extent.

Dr. W. H. Jordan maintained that the advantage of teaching, from the standpoint of the station man, depended quite largely upon the kind of teaching to be done, which, in the case of the agricultural colleges, is very largely the teaching of fundamentals. Such teaching he held to be of no advantage to the investigator, although he conceded that a small amount of teaching of an advanced character along specialties with which the investigator is dealing might prove advantageous.

It developed from the discussion that the plan of requiring this dual service from station men was regarded largely as one of expediency, and that the requirement of too much teaching from men holding important positions on the station staff had an unfavorable effect upon the general character of the station work. It was urged that the teaching should be so arranged on the college schedule as to interfere as little as possible with the time of the station worker, and that the tendency should be in the direction of restricting the amount of teaching and limiting it to advanced work. The discussion served to enunciate anew the true function of the experiment station as an institution primarily for the high grades of experimentation and research and to emphasize more strongly than ever before the great need of a sharper differentiation between its work and its corps of workers as distinguished from the instruction department of the college.

The matter of federating the farmers' organizations and societies in the different States was brought up, and it was shown how these federations had been able to assist the colleges and stations in bringing about an appreciation of their work and in securing favorable legislation. A committee, consisting of H. J. Wheeler, C. D. Woods, and H. J. Patterson, was appointed to take up the matter in the different States by correspondence.

The extent to which specialization and equipment for agricultural instruction and investigation are being carried was exemplified at the Iowa State College, at Ames, where the convention spent an interesting and profitable half day as the guests of that institution. Here the large amount of live stock kept primarily for instruction purposes, the new pavilion for stock and grain judging, the well-equipped new department of farm mechanics, the commodious soils laboratory, the new dairy building in process of construction, and the plans for the new agricultural building to cost from $250,000 to $300,000, as well as the other departments of longer standing, were typical of the rapid advancement in the material equipment for agricultural education which will place that department on a par with engineering at the better institutions.

# ANNUAL REPORT OF THE ALASKA AGRICULTURAL EXPERIMENT STATIONS, 1904.

By C. C. Georgeson, *Special Agent in Charge.*

## WEATHER CONDITIONS.

For the first time since these investigations began it becomes necessary to report the failure of many crops under experimentation. The season has been the coldest on record in the coast region. In the interior the season was cold and backward, but some of the early grain matured and some of the vegetables grew better than on the coast. South of the coast range, along the entire stretch from Portland Canal to Unalaska, grain has been a complete failure, the summer not being warm enough to mature it. Vegetables of even the hardier sorts have been a success only when the garden happened to be located in sheltered places. Potatoes have yielded but one-fourth of a crop in weight, and often half of these are too small for use. Cabbages have failed to head, and even turnips, ruta-bagas, and carrots have done poorly. The weather reports submitted herewith tell the story of low temperatures, continual rain, and lack of sunshine. Cloudy, rainy weather has also prevailed in the interior to a much greater extent than is normal for that region. Nevertheless, there was enough sunshine to mature quick-growing early crops. At the Copper Center Station nearly all of the Sixty-day oats, a variety imported from Russia by the U. S. Department of Agriculture, matured; and at Rampart Station, in latitude 65° 30′ N., 3½° north of Copper Center, all varieties of barley and oats matured; and it is to be noted that grain has matured at Rampart every year since we began work there. The explanation is to be found in the fact that there is more sunshine during the summer months in that latitude than in the region farther south.

It should be noted that the winter of 1903–4 was unusually severe, particularly in the coast region; not, indeed, in excessively low temperatures, but in moderately low temperatures long continued, accompanied with high winds. The snowfall was light, and vegetation not in sheltered places suffered from the cold, drying winds. Salmon berries, blackberries, and cranberries among the native vegetation were killed in exposed places. This year there are none of these berries in Alaska except in sheltered spots. Fifty per cent of the native elderberry bushes on Castle Hill, Sitka, were killed by the cold. These facts will account for the killing back of the young wood on much of our nursery stock, and, followed by a cold summer with little sunshine, tree growth is naturally backward.

## BRIEF SUMMARY OF WORK.

Since the last report the following has been accomplished at the several stations:

### CLEARING LAND.

Twenty-one acres have been cleared at the Copper Center Station. This, with the 16 acres under culture the past season, will make 37 acres available for culture at that station. Only 6 acres of the newly cleared land has been broken, but it is hoped to break most of the remainder in the spring in time for seeding.

At Kenai Station 3½ acres have been cleared, fenced, and broken, making 24½ acres under culture at that place. At Rampart Station 2½ acres have been cleared and broken and will be fenced, giving us 3 acres at that station, and at Sitka 1 acre has been cleared and fenced and partly drained, which increases the amount cleared to 6½ acres.

### BUILDINGS AND IMPROVEMENTS.

At the Copper Center Station a log house 16 by 24 feet, with a shed attached, has been completed and is now occupied by the superintendent of the station. A log barn 20 by 24 feet with large sheds has been so far completed as to be in use, and a cache and seed room raised from the ground has been built.

At Rampart Station an addition 12 by 16 feet has been added to an old log cabin so as to make the place habitable for the superintendent.

At Sitka Station a house has been built over the large rain-water tank, and a propagating house 10 by 20 feet, with attached workroom 10 by 15 feet, is under construction, though not quite completed at this writing. A large manure shed has been built as an addition to the barn. Another improvement has been accomplished by putting the city water into the main building.

### EQUIPMENT AND SUPPLIES.

A complete equipment of tools, implements, and machinery has been purchased for the Rampart Station and safely delivered at its destination. Nursery stock has been purchased for the growing nursery at the Sitka Station, and seed grain and fertilizers have been purchased for all the stations.

## EXPERIMENTS.

Detailed accounts of the experiments at each station are submitted herewith. At the Copper Center Station the main aim has been grain growing. To this end all the hardy, early maturing varieties of small grain that we have been able to produce have been grown. Experiments to ascertain the effect of fish guano as a fertilizer on the growth of these grains have been under way. Some grasses and forage plants have been grown, and also a small amount of the common hardy vegetables.

The experiments at the Kenai Station may be said to be in a transition stage from that of grain growing to dairy work. The summers are too cool at Kenai for grain growing, but stock feed can be grown in any quantity. We have four milch cows now at the station, and it is hoped that we can increase this number to a dozen or more and to supply the station with the necessary utensils to run a small dairy. Mr. Ross has made a little butter, which he reports to be of fine quality. The farm was seeded to grain under various forms of fertilizer experiments, but since the grain failed to mature and had to be cut for hay no conclusions can be drawn, except the broad general statement that fertilizers stimulate the growth in a large degree.

The Rampart Station has been and will be devoted wholly to the problems involved in grain growing, with such horticultural efforts as it may be practicable to undertake.

The experiments at the Sitka Station have in the main consisted in testing the growth of varieties of fruits which give promise of some degree of success. To this end nursery stock of many varieties and from several sources has been procured. The tests are confined to early maturing sorts, the stock selected being from nurseries in the coldest regions in the United States. An attempt is being made to propagate raspberries and currants for distribution, which have done well here. Several thousand apple seedlings, grown from selected hardy varieties, have been procured from the Minnesota Experiment Station. These will be used partly for propagation and partly to send out over the Territory before propagation to test their hardiness.

Fertilizer experiments proved that the soil needs lime, though they were inconclusive in other respects owing to the crops failing.

## GRASS INVESTIGATIONS.

In compliance with the suggestion made in my last report that specialists in the Department could cooperate with us in scientific investigations, Prof. C. V. Piper, of the office of the Agrostologist, Bureau of Plant Industry, made a trip of two months' duration along the coast region from Sitka to Unalaska for the purpose of investigating which species of grasses and forage plants are of practical value in that region, to determine the value of the grazing lands, and to make collections of the flora. Professor Piper's report is submitted herewith. It covers very satisfactorily the ground he has gone over. But there are still extensive regions in the Territory in which no investigations of that character have been made. Numerous inquiries reach this station about the grazing conditions in the Aleutian Islands. There is but little definite knowledge on the subject, and no one connected with the station can spare the time to spend a summer among these islands. It will take a full season's work, considering the lack of transportation facilities along the islands, and the work can not be done except by special provision for the use of a boat. If arrangements could be made with the Navy Department to secure one of the navy launches, used in connection with the building of the coaling station on Kiska Island, it would be very desirable. There are also stretches of pasture lands in the interior, which it will take two seasons to investigate fully. I therefore recommend that this work be continued and suggest that it can not be placed in better hands than those of Professor Piper.

## ENTOMOLOGICAL WORK NEEDED.

No entomological investigations have been made in Alaska. The station receives frequent complaints of injurious insects attacking garden vegetables, and as there is no entomologist connected with the station it would be very desirable if arrangements could be made with the Department by which an expert from the Bureau of Entomology could be detailed to spend a season in Alaska.

## INTRODUCTION OF CATTLE.

Professor Piper refers with some detail to the efforts that are being made at stock raising as a commercial enterprise, and it is not necessary to dwell on it further than to renew the recommendation made in former reports that an appropriation be made for the introduction of breeds suitable to the climatic conditions prevailing in the Territory. The cattle which are now here are not well adapted either to the wet weather of the coast or the cold weather of the interior. The writer believes that the Government would confer a lasting benefit on the Territory by introducing the Galloway breed of cattle and such hardy sheep as the Black-faced Scotch. For dairy purposes a strain of milking Shorthorns will be better adapted to the country than the Jerseys or Jersey grades, which are at present most common.

### TEACHING GARDENING TO THE INDIANS.

The writer ventures to renew his recommendation that steps should be taken to teach vegetable growing to the natives of Alaska. They are slowly acquiring a taste for vegetables, and their demands for seed are yearly more numerous. They know nothing about the culture of plants aside from potatoes and turnips. Instead of feeding them with rations it will be cheaper to send an instructor in gardening to visit the principal villages, supply them with seed, give practical instruction in their culture, and perhaps maintain model gardens for a few years. It will cost less than to supply them with food, and the Indians will be better off in the end.

## REPORT OF C. V. PIPER ON THE GRAZING LANDS OF THE SOUTH ALASKA COAST AND THEIR POSSIBLE UTILIZATION.

The following is a report of investigations made during the summer of 1904, in which the Alaska Experiment Station, through the Office of Experiment Stations, cooperated with the Bureau of Plant Industry, represented by the office of the Agrostologist.

### ITINERARY.

Acting under instructions from the Agrostologist, I arrived at Sitka July 14, where three days were spent in consultation with Professor Georgeson regarding the scope of the proposed investigations and in acquiring such available data as would aid in the work. July 15 an excursion to the head of Skwashianski Bay made possible an examination of the small area of meadow lands there, which are said to be fairly typical of similar lands in southeastern Alaska. Leaving Sitka July 16, I arrived in Kadiak July 24, touching en route at Yakutat, Kayak, Orca, Ellamar, Valdez, Seward, Seldovia, Homer, Aurora, and Innerskin Bay, at most of which places opportunity was offered for a brief examination of the shore.

Six days were spent on Kadiak Island, mostly in the vicinity of Womens Bay, where a Seattle company has entered extensively into the raising of sheep and cattle.

Proceeding westward July 30, Unalaska was reached August 4. On this route, both going and returning, brief stops, varying from one to twelve hours, were made at Uyak, Karluk, Cold Bay, Chignik, Unga, Sandpoint, Bellkofski, Unimak Pass, and Dutch Harbor. Though these stops were brief, they enabled me at most places to make a survey of the neighboring lands.

August 10 I was again in Kadiak, and on the following day reached Seldovia, on Cook Inlet.

In order to examine the Kenai peninsula, and especially Kachemak Bay, the site of the proposed Finnish colony, it was necessary to travel by sloop, a slow but fairly satisfactory mode of progress. Eight days were thus spent, visiting Homer, Aurora, Port Axel, the Finnish colony site, Anchor Point, Ninilchuck, Kussilof, and Kenai.

Leaving Seldovia August 23, Yakutat was reached on August 29, touching en route most of the places visited while going west. Five days were spent near Yakutat examining the surrounding region, and especially the flat meadow lands lying along the Ankou and Setuck rivers. September 4 Sitka was again reached.

## INTRODUCTION.

The south Alaska coast from Portland Canal, its extreme southeastern inlet, in longitude 130° W., to Unalaska, in longitude 166° W., forms almost a semicircle, its diameter being the fifty-fourth parallel, and its most northern points, Valdez and Tyonook, lying just north of the sixty-first parallel. The total length of this stretch of coast, ignoring bays and inlets, is about 2,000 miles.

Officially, the region from Mount St. Elias, longitude 141° W., southeastward is designated southeastern Alaska. Westward of Mount St. Elias the coast region forms southwestern Alaska.

From a biological standpoint, Cook Inlet forms a much more natural point of division. Eastward from this inlet the land is for the most part densely covered with timber, while to the westward the lands are mainly grass covered and devoid of timber.

Of the islands to the westward of Unalaska little is known from the standpoint of agriculture, no examination with this end in view ever having been made.

The total area of the grass lands of the south Alaska coast approximates 10,000 square miles. Nearly all of this lies between Cook Inlet and Unalaska. Of this total area at least one-half would seem to be capable of utilization. Much of this last is covered with tall and rank grasses, often 6 feet high. The remainder, lying in more exposed situations or at higher elevation, produces grasses that are too short for hay cutting, but furnish splendid pasturage.

## GRAZING LANDS OF SOUTHEASTERN ALASKA.

### THE YAKUTAT PLAINS.

The only extensive areas of grass lands known in southeastern Alaska are those lying in the river valleys near the coast south of Yakutat. Inasmuch as these lands have been several times referred to in reports, and as they are now in part accessible owing to the building of the Yakutat and Southern Railway, a careful examination was made of them. This railway has been built primarily to tap the several rich salmon streams flowing into the ocean south of

Yakutat, it being impracticable to fish them by approach from the ocean. The railway, which is projected to be built to the Alsek River, a distance of 45 miles, at present is built only to the Setuck River, 10 miles from Yakutat.

Practically the whole of this region is an old glacial moraine composed of fine gravel, which slopes very gently to the seashore. The land close to the seashore is somewhat higher than that lying behind and is heavily timbered. Owing to this strip of higher land, most of the streams flow parallel with the coast for some distance near their debouchments. It is along the valleys of these streams that the grass lands lie, but owing to the flatness of the land and the slight elevation above the sea level they are very poorly drained, notwithstanding the gravelly nature of the soil.

Traveling along these rivers in a canoe one receives the impression that the grass is tall and rank on these flat lands. This, in fact, is the case on a very narrow strip just along the river banks, where there is fine growth of bluetop (*Calamagrostis langsdorfii*) and sedge (*Carex cryptocarpa*). This strip of tall grass is, however, nearly always confined to the immediate banks of the rivers. The great mass of the land is covered with a thin layer of bog moss, which supports but a scant vegetation of grass and sedges less than a foot high.

It is a conservative statement to say that fully 80 per cent of these Yakutat grass lands are thus scantily grassed. Apart from this meager amount of grass, which practically precludes the cutting of winter forage, another serious difficulty presents itself in the fact that poison parsnip (*Cicuta douglasii*) occurs quite plentifully over all the land that is the least boggy, which, as before stated, is 80 per cent of the area. Thus, even if these meadows were used for grazing, great care would need to be exercised in the spring, when grass is scanty and the sweet but very poisonous tubers of this plant are frequently forced to the surface by the frost.

While the above statements are true concerning the Yakutat meadows as a whole, there are small areas which are exceptional. For example, along the lower Ankou occurs a narrow strip of several hundred acres well grassed with silvertop (*Deschampsia cæspitosa*) and beach rye (*Elymus mollis*) and free from Cicuta. Care would need to be exercised in utilizing even this, as the surrounding boggy lands bear an abundance of poison parsnip.

Again, the strip of land lying just within the ocean dunes is often well grassed with beach rye and red fescue (*Festuca rubra*).

A particularly good area of arable land lies along the railway where it reaches the Setuck River. This consists of 3 or 4 square miles of gravelly, well-drained, level land, at present looking much like a run-out meadow. It is apparently very well adapted to such cultivated grasses as smooth brome and tall meadow oat grass. It will undoubtedly grow all sorts of hardy vegetables. The present grass covering is rather scanty, but it is probable that this can be greatly increased by cultivation. This particular piece of land is well worthy of homesteaders' attention.

It is within the bounds of possibility that the larger part of the Yakutat plain can be drained and made into fine meadow lands. In their present state, however, they are not adapted to stock raising, with the exception of such small areas as above noted.

### OTHER GRASS LANDS IN SOUTHEASTERN ALASKA.

Apart from the Yakutat plains there are no extensive grass areas known in southeastern Alaska. Along many of the quiet inlets and channels are narrow strips of grass on the higher beaches composed largely of beach rye, but the acreage of these is always small. At the heads of some of the inlets more extensive areas of a similar character occur, some of which may contain 100 acres or more. The lower portions of such flats are covered with sedges and beach rye, while in the higher portions bluetop (*Calamagrostis langsdorfii*) is the principal grass.

Where such lands lie near enough to the towns they furnish admirable sites for small dairy or stock farms, and undoubtedly many of them will be so utilized.

### GRAZING LANDS OF SOUTHWESTERN ALASKA.

#### THE KENAI PENINSULA.

That portion of the Kenai Peninsula lying on Cook Inlet and north of Kachemak Bay, comprising an area 100 miles long by 20 to 30 miles wide, is an extensive plateau. Its southern portion, on Kachemak Bay, lies 500 to 1,000 feet or more above the sea level. It slopes mainly to the westward, so that the portion from Anchor Point northward is but 100 to 200 feet above the sea level. Most of this land is timbered, but there are considerable areas of grass lands near Anchor Point, near Homer, and at the site of the proposed Finnish colony.

At Homer there is an extensive sand spit about 4 miles in length and from one-quarter to 1 mile across. This spit supports a good growth of several grasses and sedges. Beach rye (*Elymus mollis*) is the most important and most abundant, but red fescue (*Festuca rubra*), bluegrass (*Poa pratensis*), and seashore grass (*Puccinellia* sp.) furnish considerable grazing. At the base of the spit the land rises gradually to the high plateau above, the scattered timber giving the appearance of mountain parks. The open portions of this land support a luxuriant growth of bluetop (*Calamagrostis langsdorfii*)

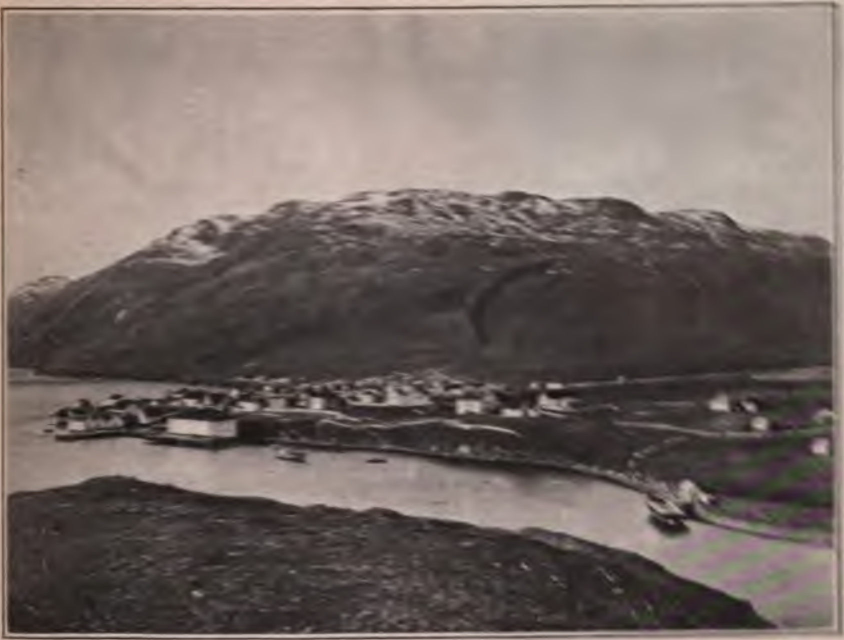

FIG. 1.—VIEW OF KADIAK, SHOWING CHARACTERISTIC TOPOGRAPHY OF THE ISLAND.

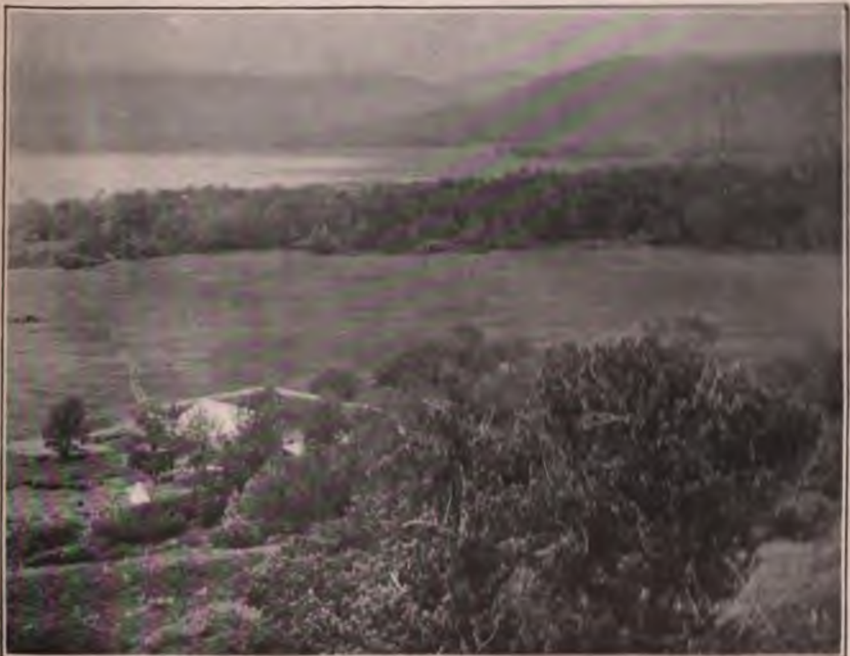

FIG. 2.—VIEW OF LOW MEADOW LANDS AT HEAD OF WOMENS BAY, NEAR KADIAK.

often 6 feet tall. At a rough estimate the grass lands in this vicinity comprise about 2,000 acres.

The site of the proposed Finnish colony is on the north side of Kachemak Bay, not far from its head. From the colony site to the head of the bay are extensive tide flats, which are mainly covered with sedges about 2 feet high. The marshy nature of these lands, together with the coarse nature of the forage, makes them of but limited value. Undoubtedly they can be much improved by diking.

The grass lands of the colony site proper consist of about 500 acres of excellent land covered with a luxuriant growth of bluetop 5 to 6 feet high. These lands lie close to the seashore and less than 100 feet above it. Back of these lands are high hills, 500 to 1,500 feet high, the plateau on the top of which consists in part of extensive grass areas. Much of this grass consists of bluetop often 6 feet high. Other areas are pure growths of Siberian fescue (*Festuca altaica*). Interspersed with these are several other good grasses, among them *Agropyron violaceum*, *Alopecurus alpinus*, *Bromus richardsonii*, and *Deschampsia cæspitosa*. These plateau grass lands are apparently very extensive. To render them accessible will, however, require the building of roads or trails up to the easiest slopes. At Anchor Point there is but little grass land near the seashore, but on the plateau behind are considerable areas much like those just described. The plateau at this point is, however, much lower.

An important fact in relation to all of the grass lands of this region is that they are underlaid with coal, which is exposed for miles in the bluffs along the coast. In view of this fact, it is doubtful if title to the land can be gained by homesteading it.

At Kenai there are no naturally grassed lands, except the sand dunes along the beach and the marshes lying inside of them. The dunes are covered principally with beach rye (*Elymus mollis*) and bighead sedge (*Carex macrocephala*). In the brackish marshes occur red fescue (*Festuca rubra*) and Puccinellia. Here also is found poison parsnip (*Cicuta douglasii*), and there is a record of some native cows having been killed by it several years ago.

### KADIAK ISLAND.

Kadiak Island is about 100 miles long by 50 miles wide. It is mountainous in character, the hills rising quite abruptly from near the seashore to heights of 1,000 to 3,000 feet (Pl. VII, fig. 1). At the end of July there was still considerable snow at 2,000 feet, but this is said to be quite exceptional.

The island is much cut into by long, narrow bays or fiords, into the heads of which flow streams. In such places are usually quite extensive areas of flat lands, luxuriantly covered with grass (Pl. VII, fig. 2). The slopes up to 1,500 feet altitude are also well grassed, excepting where there are thickets of alder or willow, but they are usually too steep to utilize otherwise than by grazing. The total area of these hillside lands is much greater than that of the approximately level lands, at least in the proportion of 20 to 1.

On the hillsides the principal grass is bluetop (*Calamagrostis langsdorfii*), which often covers large areas in a pure growth. This was exceptionally fine on hillsides burned over in March, by which means the old straw and moss were destroyed, thus permitting better drainage. In such places this grass is often 6 feet high. On the contrary, if the hills are burned over in June the fire kills the grass roots as well as the moss, with the result that fireweed (*Epilobium angustifolium*) takes possession of the ground.

Other grasses on the hillsides are relatively unimportant, though *Festuca altaica* occurs in the more gravelly lands in some abundance.

On the flat lands before mentioned a tall species of sedge (*Carex cryptocarpa*) forms a broad fringe along the shore of the bays and sloughs, especially on lands which are occasionally covered by tide water. Back of this sedge beach rye (*Elymus mollis*) forms a more or less broad zone (Pl. VIII, fig. 1), often mixed with patches of *Poa glumaris*. In the drier lands bluetop is most abundant.

These three plants furnish the great bulk of the forage on Kadiak Island, and, indeed, in most parts of the Alaska coast, but the bluetop is more abundant than all of the other grasses together.

Bluetop cures very readily, owing to its slender stems and thin leaves, making a sweet and palatable hay. Beach rye cures much less easily, owing to its thick stems. The sedge cures very slowly, even under favorable conditions, owing to its pithy stems. All three of these plants grow so luxuriantly that they yield from 2 to 3 tons of hay per acre.

Of forage plants other than grasses, a lupine (*Lupinus unalaskensis*)and fireweed (*Epilobium angustifolium*) were both abundant. They are readily eaten by sheep. A fern (*Athyrium cyclosorum*) often occupies hillsides to the virtual exclusion of other plants. It is never eaten by animals.

In the immediate vicinity of Kadiak the lands have been quite closely grazed for years past by the village cows. In such closely grazed lands the principal grasses were bluegrass (*Poa pratensis*) and wild barley (*Hordeum boreale*). The latter is not much relished by cattle.

A very similar condition on closely grazed lands was noticed also at Kenai. The facts point to the probability of bluetop being a grass that will give way under close grazing; but as bluegrass readily replaces the native grasses, permanent pastures of the best kind are assured.

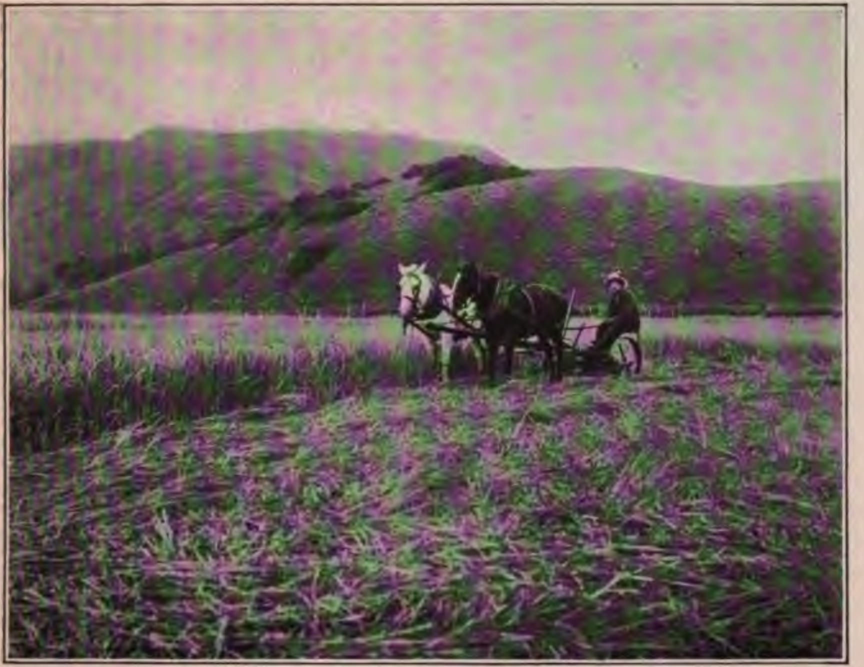

FIG. 1.—MOWING BEACH RYE, FRYE-BRUHN RANCH, NEAR KADIAK.

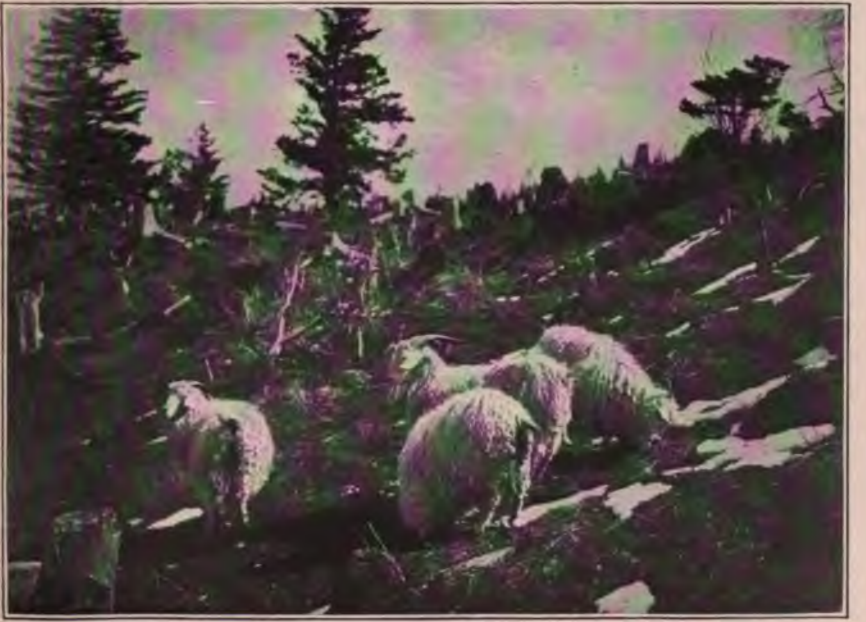

FIG 2.—ANGORA GOATS, WOOD ISLAND, NEAR KADIAK.

The islands lying adjacent to Kadiak are very similar to it in character, with the exception of Afognak, which, like the northwest corner of Kadiak, is timbered with spruce.

## ALASKA PENINSULA AND ADJACENT ISLANDS.

The whole region to the westward of Kadiak might briefly be described as being similar to Kadiak, but entirely devoid of timber, the shrubs more scrubby, and the grass less luxuriant. The land is none the less splendidly adapted to grazing, a large variety of grasses occurring. It is only in favored spots that the grasses are as luxuriant as on Kadiak, though the species are for the most part the same. On the hills occur extensive areas of crowberry (*Empetrum nigrum*), locally called " moss," which in places seriously limits the amount of grazing.

Much of the Alaska Peninsula is far too mountainous to be desirable for stock raising, but where valleys occur near the heads of numerous inlets the land often lies very favorably.

### UNALASKA.

This island differs but little in its vegetation from Kadiak, though the plants as a rule are less luxuriant. The principal grasses are silvertop (*Deschampsia cæspitosa*), beach rye, bluetop, and *Calamagrostis aleutica*. The latter occurs but sparingly to the eastward, but is quite abundant on this island.

Some difficulty would be experienced on Unalaska in finding grass sufficiently rank to cut for fodder, especially if a large quantity were necessary. A cultivated field of bluegrass and white clover in the town was, however, as fine as any I have ever seen. Small areas of beach rye are nearly as luxuriant as the same grass farther eastward.

### BROWSING LANDS.

On Kadiak Island and to the westward the mountain sides are often covered with a dense growth of alder (*Alnus sinuata*) 3 to 10 feet high, and to a less extent low willows of several species form copses in wet places. These latter especially are said to be eaten readily in winter by cows and sheep, and goats are said to eat any of the deciduous shrubs. In some places these shrubs cover the ground almost to the exclusion of other plants.

In the region to the eastward of Kadiak there are likewise many places where this same alder, together with willows, salmon berry, huckleberry, and other deciduous shrubs, forms a large part of the vegetation. This is especially true of many places about Prince William Sound.

### WINTER FEED.

Owing to the damp summer climate, the curing of hay on the Alaska coast is a difficult matter. With three days of favorable weather bluetop will cure perfectly, and where one needs but a small quantity of hay no particular difficulty is experienced in getting it. On the contrary, where a large quantity of winter feed is needed it is practically impossible to secure it. Under such conditions resort must be had to silos. Without question the bulk of the winter feed used in Alaska will have to be silage. The experience of Professor Georgeson and others with beach-rye silage has been entirely satisfactory, and doubtless other plants will furnish an equally good silage.

The following analyses of the three most common grasses or grass-like forage plants of the Alaska coast have been made through the courtesy of the Bureau of Chemistry. Their value can only be accurately determined in connection with digestion experiments. These three plants are bluetop (*Calamagrostis langsdorfii*), sedge (*Carex cryptocarpa*), and beach rye (*Elymus mollis*).

*Composition of Alaskan forage plants.*

| | Moisture. | Ash. | Ether extract. | Crude fiber. | Proteids. | Nitrogen-free extract. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Bluetop | 7.18 | 3.90 | 1.03 | 42.94 | 4.58 | 40.37 |
| Sedge | 5.85 | 10.65 | 2.12 | 25.72 | 10.32 | 45.34 |
| Beach rye | 11.92 | 7.51 | 2.26 | 30.31 | 12.71 | 35.29 |

## UTILIZATION OF SOUTHERN ALASKA GRAZING LANDS.

### SHEEP HUSBANDRY.

The only sheep seen in Alaska were on the ranch of the Frye-Bruhn Company near Kadiak, where about 80 head were seen in excellent condition. These sheep are the remnant of 9,000 head which were introduced from Oregon in 1902 and 1903, the remainder having perished. At first sight it would seem that this appalling loss of over 98 per cent is concluisve evidence that sheep raising in Alaska is not likely to prove profitable. Inquiry into the causes of the mortality does not necessarily bear out this conclusion. Five hundred of the sheep were drowned in March, 1903, by being caught at the head of a narrow cove by the incoming tide. One hundred and fifty head were lost by becoming frightened and jumping over cliffs. The rest of those that died succumbed from scab, which broke out in January, 1903. Owing to lack of shelter it was then impossible to dip them, as that treatment in winter would have been equivalent to killing them. The result was that all but about 80 died of the scab. Thus all the mortality was due to causes entirely preventable. It was interesting to know that several head of sheep which ran wild survived the winter without care.

At Uyak I was informed that 4 head of sheep survived the winter of 1903–4 without care.

Some years since the Alaska Commercial Company had a band of about 50 sheep on Kadiak, the remnant of a considerably larger lot imported from San Francisco. Of the original importation the greater portion died the first winter, some say from scab, others from cold and neglect. At any rate, this venture seems not to have been a success, the last of the sheep having been killed about six years since. Various informants have reported so differently to me on the facts concerned with this that it does not seem advisable to consider it either as evidence for or against the possibility of successful sheep raising. It is worthy of note, however, that both these lots of sheep were imported from the semiarid regions of Oregon and California and brought to a moist and colder country.

There seems to be a general unanimity of opinion in Kadiak that in an ordinary winter sheep can not be safely left without care after the beginning of January. Indeed, many would place the time a month or six weeks sooner. New grass never appears before May 15, and often not until June 1. Therefore, under the best of conditions, sheep will need four and one-half months of feeding and shelter. The superintendent of the Frye-Bruhn ranch, after one winter's experience, thinks it will be more than this.

Another serious difficulty lies in the lateness of the lambing season. It is generally agreed that lambing should not take place before June 1. The lambs will need shelter and feed by December 1 or earlier, unless one takes serious chances of losing many.

Whether sheep raising can be profitable at present under such conditions remains to be demonstrated. The mere fact that sheep in small numbers have wintered without care is no proof that successful sheep husbandry can thus be carried on, nor even that one or two months' feeding should suffice. The risks in such procedure are too great to warrant a careful stock raiser in taking the chances.

Destructive wild animals are no menace to sheep raising on Kadiak and other islands. Eagles may destroy a few lambs, but these birds are easily exterminated. Kadiak bears are too scarce and too easily destroyed to merit consideration. On the mainland wolves may prove troublesome.

In the light of present knowledge one can be safe in saying that sheep can be raised on the Alaska coast if adults are given five months' feed and shelter and the lambs a month more. That such sheep husbandry will be profitable is problematical.

Owing to the damp climate, foot rot is a disease to be feared. Unusual care should therefore be exercised to import only perfectly healthy animals.

While the outlook for successful sheep husbandry is, in my opinion, doubtful, it is desirable that some of the hardy northern breeds be tested. Where browse is abundant it is not unlikely that such animals may prove decidedly profitable.

### ANGORA GOATS.

Rev. C. P. Coe, of Wood Island, has several head of Angora goats (Pl. VIII, fig. 2), which have passed the last two winters with but little care. This year his herd has shown very satisfactory increase, and no difficulty is anticipated in wintering the kids. These animals bid fair to be very successful along the Alaska coast wherever there is abundant browse and where the winter snowfall is not too great. From Kadiak westward there can be but little doubt as to their being a success, and even in southeastern Alaska it is altogether likely that they will thrive. Owing to their tractability and the ease with which they are kept, Angora goats should prove most useful animals for the natives as well as for whites.

### BEEF RAISING.

Two Seattle companies have already begun to raise beef cattle in southwestern Alaska. The Frye-Bruhn Company have 200 head, mostly Herefords, on Kadiak Island, while another company is beginning operations on Akun Island. The former company began operations with cattle in July, 1903, with about 260 head. During the winter of 1903–4 about 140 head of these were lost, mostly by falling over cliffs. Owing to the fact that the earliest grass appears on the steep southerly slopes, the cattle crowded in such places. In some instances the sod, loosened by the frost, gave way and precipitated them over the cliffs. In other cases the cattle used their horns when crowded, the wounded ones losing their footholds in endeavoring to escape. As precautions more care is now used in selecting their feeding grounds and the cattle have been dehorned.

Cattle of various breeds have been raised for years past at nearly all the settlements along the coast. When they belong to the natives they are forced to exist through the winter with little or no care, eking out an existence by feeding on browse and seaweeds. Milch cows kept by whites are fed from five to six months, as a rule. This winter the manager of the Frye-Bruhn Company ranch is preparing to feed his beef cattle five months or more, and it would seem that such a course is better economy than to keep them half starved on such feed as they can find.

It is possible to raise many times more beef on the Alaska grass lands than the present population there can use. The only other markets available at present are the Pacific coast cities. Whether it will prove profitable to raise beef in Alaska and market it in Seattle and other coast cities remains to be demonstrated. Apparently there is no other outlet for surplus Alaska cattle, but with a sufficiently large supply there seems no reason why in time such a trade should not be remunerative.

Cattle fatten readily in spring on Alaska grasses, and keep in fine condition till late into the fall. Some Herefords slaughtered at Kadiak in July furnished as fine beef as any I have ever seen or eaten.

### DAIRYING.

Milch cows of various breeds have long been kept at most of the coast settlements, and the common testimony is that they do exceedingly well while feeding on the green grasses. Professor Georgeson's tests have demonstrated that they keep up an excellent milk flow on beach-grass silage, and doubtless the other grasses are quite as nutritious.

For two reasons I am impelled to believe that the utilization of the Alaska grass lands will yield most profit through dairying: (1) Because of the necessarily long feeding period—five to six months—during which only dairy cows yield a compensating return, and (2) the freight to distant markets on concentrated products like butter and cheese is not a serious factor.

There are many admirable sites for dairy colonies or settlements, not only on Kadiak Island, but also on other islands and on the mainland. Dairying is to be one of the chief industries in the proposed Finnish colony on the Kenai Peninsula. With such an enormous wealth of grass as southwestern Alaska possesses it is difficult to doubt that it will become a great dairy country. It is doubtful if equally good opportunities for colonies of dairy husbandmen can be found in the United States to-day. Certainly there is no place left where 320-acre homesteads of magnificent grass lands can be had for the taking.

### RECOMMENDATIONS.

In view of the enormous area of the southwestern Alaska grass lands it seems most advisable that this undeveloped resource be converted into wealth. Perhaps nothing will stimulate this more than a live-stock experiment station. The peculiar problems connected with stock raising in Alaska are likely to prove expensive to pioneers, as indeed has already been proven. There are still many problems confronting the stock raiser which it is clearly the province of an experiment station to solve.

Among the most important lines of work thus presented are the adaptability of different breeds, both of sheep and cattle, to the conditions; the relation of available winter feeds, both to fattening and to milk flow; the investigation of such plants as lupine and fireweed for silage, and the further investigation of forage plants for cultivated fields, especially of legumes.

Such a live-stock experiment station would, in the opinion of the writer, best be located on Kadiak Island, or one of the islands immediately adjacent. The conditions there are fairly representative, these islands being better grassed than most of the regions to the westward, while they have a shorter season than the equally well grassed lands of Cook Inlet. Such an establishment should do much to stimulate the rapid utilization of a great resource.

## NOTES ON THE GRASSES AND OTHER FORAGE PLANTS OF THE ALASKA COAST.

### GRASSES.

*Savastana odorata* (L.) Scribn., Vanilla grass.—A sweet-scented grass often used by the Indians in basketry. It occurs in meadows, usually scattered among other grasses, very seldom making a pure growth. This grass has but little forage value.

*Savastana alpina* (Lilj.) Scribn., Alpine vanilla grass.—Very similar to the preceding, but much smaller and with a denser inflorescence. It was observed only on Kadiak Island, at about 1,000 feet above sea level, but is known to occur quite generally along the Alaska coast, in the mountains.

*Phleum alpinum* L., Mountain timothy.—This grass was observed at almost every point examined. Luxuriant specimens may be 2 feet high or more, but the grass is usually shorter. Owing to its rather scanty leafage and low growth it has not been considered of agricultural value, but it is worthy of such trial in Alaska.

*Phleum pratense* L., Timothy.—This important agricultural grass is only sparingly introduced along the Alaska coast. Even where established it shows no tendency to become aggressive, but, on the contrary, appears but poorly adapted to the conditions. A few plants observed were, however, tall and vigorous, suggesting that by selection a variety might be secured which would be agriculturally successful. The possibility of securing a valuable grass by hybridizing this with the preceding species is also worthy of investigation.

*Alopecurus alpinus* J. E. Smith., Mountain foxtail.—A rare grass on the south Alaska coast, but growing 3 to 4 feet high. While too scarce to be a factor in the amount of native forage, it nevertheless may prove of cultural value, and should be tested.

*Alopecurus geniculatus* L., Water foxtail.—Infrequent, and of but little forage value.

*Arctagrostis arundinacea* (Trin.) Beal.—This grass much resembles bluetop, having the same habit and, like it, growing 4 to 7 feet high. It is not uncommon along Cook Inlet and is certainly worthy of testing in cultivation.

*Cinna latifolia* (Trev.) Griseb., Wood reed grass.—A tall grass with drooping panicles, found mainly in woods or copses. It is not sufficiently plentiful to be of much value.

*Agrostis alba* L., True redtop.—This well-known grass was observed at but two points—namely, Yakutat and Homer—being clearly introduced at each place. It thrives well and seems to be aggressive. We judge it to be one of the grasses that will prove of high value for grazing in case the native grasses tend to disappear. True redtop should not be confused with the grasses called "redtop" on the Alaska coast. There are two grasses thus misnamed, bluetop (*Calamagrostis langsdorfii*) and silvertop (*Deschampsia cæspitosa*).

*Agrostis hyemalis* (Walt.) B. S. P., Rough hair grass; *Agrostis geminata* Trin.; *Agrostis æquivalvis* Trin.; *Agrostis mertensii* Trin., and *Agrostis rossæ* Vasey.—The foregoing five species are small grasses which furnish practically no forage.

*Agrostis exarata* Trin., Whitetop.—This species quite closely resembles true redtop, but has a closer pale green panicle and no creeping rootstocks. The larger forms of it grow 2 or 3 feet high, and under some circumstances may be worthy of cultivation.

*Agrostis melaleuca* (Trin.) Hitchcock.—Interesting as being the characteristic Alaska coast grass on the sphagnum bogs. Its slender stems, scarce a foot high, furnish, however, but little forage.

*Calamagrostis langsdorfii* Trin., Bluetop.—The most abundant grass on the Alaska coast, growing luxuriantly from sea level up to 1,000 feet elevation. Extensive areas of this grass are often 6 or 7 feet high, which during the summer months makes traveling toilsome labor. The usual name applied to this grass in Alaska is "redtop," but as the name really belongs to a well-known agricultural grass which is beginning to appear in Alaska, we would suggest "bluetop" as a more appropriate name, the panicle being blue-purple rather than red in color.

*Calamagrostis aleutica* Trin., Aleutian reed grass.—Found but sparingly at Sitka, Latouche, and Unalaska. Too scarce to be of forage value.

*Calamagrostis* n. sp.—Kadiak, in low meadows. A small species allied to *C. deschampsioides* Trin.

*Deschampsia bottnica* (Wahl.) Trin., and *Deschampsia cæspitosa* (L.) Beauv., Silvertop.—These two closely allied species occur mainly in low-lying meadows near the seashore, often indeed in places which the high tides cover. They furnish excellent grazing, but owing to the nearly leafless stems yield but little hay.

*Deschampsia curtifolia* Scribn.—A dwarf species occurring on gravelly soil.

*Deschampsia atropurpurea* (Wahl.) Scheele.—Found at Unalaska and Latouche. It is of no economic importance.

*Deschampsia calycina* Presl., and *Deschampsia elongata* (Hook.) Munro.—Both these species were found along the railway at Yakutat; undoubtedly introduced.

*Trisetum cernuum* Trin.—A woodland grass of no economic value collected at Sitka, Yakutat, and Latouche.

*Trisetum subspicatum molle* (Michx.) Gray.—In rocky soil, scarce. Found at Kadiak and Unalaska.

*Avena striata* Michx.—A few plants seen only at Kenai.

*Melica subulata* (Griseb.) Scribn.—Unalaska, on rocky cliff near the seashore.

*Poa annua* L., Annual bluegrass.—Common in yards and waste places about nearly all Alaska settlements.

*Poa stenantha* Trin.—A rather common species, but mainly confined to rocky cliffs and gravelly stream banks, and consequently of little forage value.

*Poa eminens* Presl.—A coarse species 2 to 4 feet high, growing in wet meadows near the seashore. It is not abundant enough to be of importance.

*Poa pratensis* L., Kentucky bluegrass.—From my observations Kentucky bluegrass seems not to be native along the Alaska coast, but introduced. In places it is abundant, especially about the settlements. It is an important fact that where the native grasses have been displaced bluegrass is one of the principal species to occupy the ground.

*Poa nemoralis* L.—Frequent, but growing usually on cliffs and therefore of little forage value.

*Poa lanata* Scribn. & Merrill ined.—A species closely related to *Poa pratensis*, but of coarser growth. It is common at Unalaska, and apparently would be of value in cultivation.

*Poa trivialis* L.—Apparently native in Alaska, but scarce. We saw it only at Sitka.

*Poa leptocoma* Trin. var.—Found only at Orca on stream banks.

*Poa arctica* R. Br.—A low species occurring at Kadiak and Unalaska.

*Poa hispidula* Vasey.—A tall, rather coarse species, of which a few plants were seen at Seldovia.

*Panicularia pauciflora* (Presl.) Kuntze.—Found sparingly at Sitka, Latouche, and Yakutat in wet places.

*Panicularia americana* (Torr.) MacM.—A few plants found near Homer, seemingly native.

*Puccinellia* sp.—One or more of the obscurely defined species of this genus occurs on low seashores, often in places which the high tide covers. Cows are very fond of this grass, but only in exceptional places is it abundant enough to furnish pasturage.

*Festuca rubra* L., Red fescue.—Several varieties of this variable grass occur along or near the seashores. In sandy soil it is often abundant enough to be of importance.

*Festuca altaica* Ledeb.—A densely tufted grass 1 to 2 feet high, forming small tussocks. On the plateau above Kachemak Bay there are large tracts where this is the prevailing grass. Presumably it is valuable forage, but direct observation on this point is needed.

*Festuca ovina brachyphylla* Schultes.—A very dwarf grass too scanty to furnish forage.

*Bromus aleutensis.*—Observed only at Unalaska. Rare.

*Bromus sitchensis* Trin.—A tall, coarse species, often 6 feet high, and the panicles a foot or more long and broad. It is not uncommon near Sitka and deserves trial under cultivation.

*Bromus pacificus* Shear.—Habit much like the preceding species, and, like it, deserving attention in cultivation.

*Bromus richardsoni* Link.—Observed only on the plateau above Kachemak Bay.

*Bromus hordeaceus* L.—Introduced along the railway at Yakutat.

*Agropyron tenerum* Vasey.—Not uncommon on the Kenai Peninsula. It is likely to prove a valuable hay grass in cultivation.

*Agropyron repens* (L.) Beauv., Couch grass.—Common in yards and gardens at Sitka, growing 3 to 5 feet high. It seems very well adapted to Alaska conditions and, were it not so difficult to eradicate where once established, might be recommended for trial as a hay grass.

*Hordeum boreale* Scribn. & Smith, Wild barley.—Common all along the Alaska coast, and about the villages often the commonest grass. Cows seem to avoid it, at least indicating strong preference for the bluegrasses and others.

*Elymus mollis* Trin., Beach rye.—A very common and valuable grass found along the whole south Alaska coast. It commonly forms a fringe from 10 to 100 feet wide, or sometimes more, just above high-tide mark. In such situations it grows 6 feet high. Where sand dunes are formed, as near Kenai and near Yakutat, this grass is the principal sand binder. In such situations the heads are often short and thick, the florets being somewhat proliferous. This form has been called *Elymus capitatus* Scribn., but it is merely a diseased state of *E. mollis*, both the typical elongated and the condensed heads often being found on the same plant.

*Elymus borealis* Scribn.—A grass confined to southeastern Alaska and of little value.

### SEDGES.

*Carex cryptocarpa* Meyer.—The most valuable sedge for forage along the Alaska coast, frequently covering large areas. In favorable places it grows 4 to 5 feet high. On the Yakutat plains it is an important element of the flora. Near Kadiak and near Sitka it was found covering extensive tracts of low-lying land along the seashore, the plant occupying the ground between the zone of beach rye and ordinary high-tide mark. Quantities of it were cut for feed on the Frye-Bruhn ranch, but owing to the pithy stems it dries very slowly.

*Carex macrochæta* Meyer.—A small species common on the drier land near the sea level. Cattle graze upon it readily. It is the most important dry-ground sedge.

*Carex macrocephala* Willd.—On the sand dunes at Kenai, where it is of some importance as a sand binder.

*Carex sitchensis* Presc.—A tall, abundant species, but usually growing in very wet places, so that it can scarcely be utilized.

### LEGUMINOUS PLANTS.

*Lupinus unalaskensis* Wats., Lupine.—This lupine is exceedingly abundant from Cook Inlet westward, often covering large areas in a nearly pure growth. In favorable places the plants are 3 feet high. Sheep eat it readily while green. Inasmuch as this is by far the most abundant leguminous plant in south Alaska, it is most desirable to ascertain the value of this plant as silage. It is too fleshy to be cured as hay.

*Lathyrus maritimus* (L.) Bigel., Beach pea.—Common on high seabeaches, but owing to its low growth it can not be harvested. Cattle feed readily upon it. The seeds are quite large and sweet, so that it is often used as human food.

*Lathyrus paluster* L., Swamp pea.—A much more slender plant than the foregoing and much less plentiful. Near Kadiak, however, several considerable patches of it in nearly pure growth were observed.

*Vicia sitchensis* Bong. (*V. gigantea* Hook.).—Observed only near Sitka. A very tall and leafy species, often 6 to 8 feet high, clambering over bushes. The flowers are ochraceous. The plant deserves trial in cultivation.

### OTHER PLANTS OF FORAGE VALUE.

*Fritillaria kamtschatcensis* (L.) Ker., Wild rice.—The subterranean bulblets of this plant, which resemble a mass of rice grains, were formerly much used as food by the natives. In the few places where hogs are kept they feed greedily upon these bulblets. The plant prefers the low-lying lands near the seashore.

*Epilobium angustifolium* L., Fireweed.—When hillsides are burned over in June, the intensity of the fire is usually such as to destroy grass roots. Under such circumstances a nearly pure crop of fireweed is likely to follow. Sheep eat this plant readily when green. It is desirable to test the value of the plant as silage, as its great abundance often makes its harvesting an easy matter.

## THE COMPOSITION OF SILAGE MADE FROM BEACH GRASS.

Beach grass (*Elymus mollis*) constitutes for the most part the silage material in Alaska, at least in the coast region. It is a very rank, coarse grass, and in most places yields a heavy tonnage to the acre. It grows on the flats or deltas built up by streams, at the head of bays and inlets, and occasionally along a stretch of flat, sandy beach just beyond the reach of high water, though in many places it is partly flooded at extreme high tides. As a rule, it forms a pure growth, though occasionally, particularly in low places, it is mixed with sedges.

This grass has been used to fill the station silo at Sitka every year since it was built. This year a sample which had been in the silo for just one year and taken from the middle of the silo near the bottom was sent to the Bureau of Chemistry for analysis. Doctor Wiley's letter, attached hereto, shows that this silage is exceedingly rich in nutritive elements, particularly protein, and the writer can testify from experience that it makes good feed for cattle.

SEPTEMBER 1, 1904.

Dr. E. W. ALLEN, Acting Director,
*Office of Experiment Stations, Department of Agriculture.*

DEAR SIR: Below is given the analysis of the sample of beach-grass silage from C. C. Georgeson, Sitka, Alaska, which you sent us under date of August 15.

The sample contained 69.77 per cent water. Analysis of the dried sample is as follows:

| | Per cent. |
|---|---|
| Fat | 3.32 |
| Protein | 10.64 |
| Ash | 6.89 |
| Crude fiber | 34.64 |
| Nitrogen free extract | 44.51 |
| Total | 100.00 |

Respectfully,

H. W. WILEY,
*Chief Bureau of Chemistry.*

## ANALYSES OF ALASKAN SOILS.

Prof. Milton Whitney, Chief of the Bureau of Soils, has very kindly analyzed several samples of soils sent him for investigation. Sixteen of these samples are from the experiment station at Copper Center. Table 1 gives the result of a mechanical analysis of these samples, and it also shows at which depth they were taken and their relative positions with reference to the Copper River. Most of them are deficient in organic matter, though two samples appear to be very rich in humus.

Table 2 gives the chemical analyses of these samples, and Professor Whitney's estimate of their value is indicated in his letter which refers to the subject.

Another sample of soil was sent to the station by a settler near the mouth of the Stikine River. Professor Whitney's letter on this subject gives the result of his examination.

The soils in Alaska vary so exceedingly that the examination of particular samples can not give us an idea of the character of the soil except in the immediate vicinity where the samples were taken.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS,
*Washington, D. C., March 14, 1903.*

Dr. A. C. TRUE, Director,
*Office of Experiment Stations, Department of Agriculture.*

DEAR SIR: We inclose herewith results of mechanical and chemical analyses of a number of soils forwarded by you to this Bureau some time since, these soils having been collected by Professor Georgeson in Alaska. From a physical point of view, these soils are interesting in showing unusually small amounts of medium-sized grains, on the whole. Three of them, Nos. 7654, 7655, and 7656, contain unusually large quantities of organic matter, and we would be inclined to think that they can be successfully worked only with especial care as to their drainage. The chemical analyses show no unusual features, as they all contain apparently enough of the essential mineral plant foods to supply the needs of the ordinary agricultural crop.

We would especially call your attention to Nos. 7654, 7655, and 7656 again, on account of a large amount of nitrogen present in these soils, and it is our opinion that they might be expected to respond favorably to applications of lime, if this substance can be economically obtained.

Very truly, yours,

MILTON WHITNEY, *Chief of Bureau.*

TABLE 1.—*Mechanical analyses of soil samples from Copper Center Station, Alaska.*

[Fine earth.]

| No. | Locality and description. | Organic matter. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|
| | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 7642 | (1) From third bench on Copper River, 0-6 inches | 1.37 | 0.10 | 0.60 | 0.48 | 4.02 | 17.80 | 71.22 | 5.42 |
| 7643 | (2) Subsoil of No. 7642, 6-12 inches | .65 | .06 | .48 | 1.46 | 8.38 | 15.48 | 68.12 | 5.76 |
| 7644 | (3) Subsoil of No. 7642, 12-18 inches | .67 | .14 | .78 | 2.86 | 16.18 | 27.16 | 39.02 | 14.50 |
| 7645 | (4) Subsoil of No. 7642, 18-24 inches | .49 | 1.80 | 1.32 | 2.80 | 16.32 | 24.74 | 38.96 | 14.50 |
| 7646 | (5) From second bench, near grain plats, 0-6 inches | 5.80 | .00 | .30 | .50 | 5.64 | 26.78 | 53.30 | 13.38 |
| 7647 | (6) Subsoil of No. 7646, 6-12 inches | 3.75 | .00 | .34 | 1.30 | 9.70 | 22.76 | 45.76 | 19.80 |
| 7648 | (7) Subsoil of No. 7646, 12-18 inches | .80 | Trace. | .32 | 1.62 | 16.22 | 23.40 | 41.08 | 11.92 |
| 7649 | (8) Subsoil of No. 7646, 18-24 inches | .26 | .00 | .26 | 2.08 | 15.52 | 29.78 | 42.04 | 9.64 |
| 7650 | (9) From first bench, near grain plats, 0-6 inches | 2.58 | .24 | .28 | .28 | 4.34 | 24.66 | 55.30 | 14.94 |
| 7651 | (10) Subsoil of No. 7650, 6-12 inches | 1.45 | .00 | .32 | .20 | 11.98 | 54.28 | 28.48 | 4.86 |
| 7652 | (11) Subsoil of No. 7650, 12-18 inches | 1.26 | .04 | .08 | .08 | 7.52 | 31.72 | 58.12 | 2.44 |
| 7653 | (12) Subsoil of No. 7650, 18-24 inches | 1.19 | .00 | .20 | .08 | 3.22 | 20.08 | 72.56 | 3.22 |
| 7654 | (13) From first bench, on lower ground, 0-6 inches | 43.47 | .98 | 6.20 | 5.20 | 17.90 | 20.14 | 34.62 | 14.78 |
| 7655 | (14) Subsoil of No. 7654, 6-12 inches | 30.38 | 1.94 | 5.48 | 4.46 | 12.30 | 20.56 | 41.32 | 13.90 |
| 7656 | (15) Subsoil of No. 7654, 12-18 inches | 21.00 | .40 | 1.56 | 1.48 | 5.98 | 11.54 | 55.98 | 22.70 |
| 7657 | (16) Subsoil of No. 7654, 18-24 inches | 2.89 | .04 | .46 | .28 | 1.62 | 3.96 | 52.24 | 41.20 |

TABLE 2.—*Chemical analyses of soils from Copper Center Station, Alaska.*

| Laboratory No. | Sample No. | Lime (CaO). | Potassium ($K_2O$). | Phosphoric acid ($P_2O_5$). | Nitrogen (N). |
|---|---|---|---|---|---|
| | | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 7642 | 1 | 2.16 | 0.21 | 0.32 | 0.126 |
| 7643 | 2 | 2.05 | .26 | .18 | .070 |
| 7644 | 3 | 2.47 | .41 | .12 | .074 |
| 7645 | 4 | 2.60 | .32 | .09 | .056 |
| 7646 | 5 | 3.18 | .21 | .18 | .330 |
| 7647 | 6 | 4.99 | .21 | .14 | .232 |
| 7648 | 7 | 3.93 | .22 | .14 | .070 |
| 7649 | 8 | 3.88 | .24 | .14 | .056 |
| 7650 | 9 | 3.10 | .23 | .14 | .145 |
| 7651 | 10 | 3.15 | .24 | .14 | .077 |
| 7652 | 11 | 3.00 | .15 | .11 | .063 |
| 7653 | 12 | 3.30 | .13 | .07 | .126 |
| 7654 | 13 | 5.75 | .09 | .19 | 1.250 |
| 7655 | 14 | 5.04 | .11 | .13 | 1.150 |
| 7656 | 15 | 5.02 | .29 | .12 | .561 |
| 7657 | 16 | 6.36 | .45 | .11 | .147 |

AUGUST 26, 1904.

Doctor ALLEN, Acting Director,
*Office of Experiment Stations.*

DEAR SIR: We have examined the sample of soil collected by K. J. Kruyg from near the mouth of the Stikine River, Alaska, forwarded to this Bureau some time since by you, obtaining the following results for the principal mineral constituents:

| | Per cent. |
|---|---|
| Lime (CaO) | 1.55 |
| Potassium ($K_2O$) | 1.22 |
| Phosphoric acid ($P_2O_5$) | .49 |
| Nitrogen (N) | .30 |

You will see from the analysis that so far as can be judged by this method of examination the soil is well supplied with the principal mineral plant food constituents. This sample shows 3.2 per cent of organic matter, much of which is in the form of rootlets, and therefore can not be as readily made use of by plants as if in a more decomposed state.

The texture of the soil is that of a silty loam. Probably 75 to 80 per cent of the particles are of the size called "silt." There is a very small percentage of the finer grades of sand and probably 15 per cent of clay present. This soil resembles some of the loess soils of the Mississippi Valley, especially those which have been formed by the washing of the loess from the bluffs and its redeposition along the streams. These soils are usually quite productive and yield good crops of corn, wheat, oats, potatoes, peas, tomatoes, cabbage, and other truck and market-garden crops, as well as orchard fruits. While it is not possible from the small amount of data to draw any very definite conclusions, we should expect this soil, under good drainage conditions, suitable management, etc., to prove a very productive one.

Very truly, yours,

MILTON WHITNEY, *Chief of Bureau.*

## WORK AT SITKA STATION.

The cultural work is detailed in the following notes. The weather conditions were so unfavorable that no crops of any kind reached the perfection attained in former years. This station is now devoted chiefly to the testing and propagating of fruit trees, berry bushes, and ornamentals of such kinds as give promise of succeeding in Alaska. They will then be distributed to the other stations and to others in all parts of the Territory who will agree to cooperate with us in the work of ascertaining what can be grown. The station will begin the distribution of raspberries, currant bushes, and some few fruit trees in the spring. Wild species of raspberries and currants are found more or less abundantly in the lower mountain regions of the coast range, and cultivated varieties do well everywhere in the coast region, but it is still uncertain if they can be grown in the interior. For purpose of propagation the station has procured small stocks of early and hardy varieties of apples and cherries and plums from the experiment stations in South Dakota, Iowa, and Minnesota, and from nurseries at Yankton, S. Dak., and Lake City, Minn. The notes herewith show that their growth this year has not been all that could be wished, because of the abnormally cold, backward season.

The soil at this station is new and as yet not in good condition for fruit. For this reason it will be necessary to grow crops which will improve the tilth, such as potatoes, soiling crops, and the like, for some time. With this in view, potatoes and cabbage were planted on about 2 acres and oats sown on 2 acres more. The potatoes yielded a fourth of a crop, the cabbages did not head, and the oats did not mature.

A small plantation was made of the native cranberry, which is doing well, though it had no fruit this year, and a few plants of the Eastern cranberry were secured from the Wisconsin Cranberry Growers' Association. It is difficult to get plants here alive, but some few are doing fairly well.

Strawberry plants sent here by mail are nearly always dead on arrival; but a small collection of varieties, most of which grew well in 1903, was obtained. Eighty per cent of these were winterkilled last winter.

This year a splendid start was made with the native Alaskan strawberry. Its home is on the bleak sandy beaches from Muir Glacier to Prince William Sound. It is a rampant grower, but a very shy bearer. The fruit is, however, of very fine quality and often as large as a thimble. It is hoped to produce one or more hardy varieties from crosses. Attempts at hand fertilization have not been a success so far, because the native plants are out of bloom before the cultivated varieties begin blooming. To aid in such work a small propagating house, 10 by 20 feet, with a workroom attached, 10 by 15 feet, was built. It is not quite finished at this writing.

Some fertilizer experiments were made on a small scale with oats and vegetables, using combinations of lime, fish guano, nitrate of soda, muriate and sulphate of potash, and superphosphate. Experiments with the same fertilizers in a series of pots, or rather box culture, with wheat, barley, oats, and buckwheat, were made, but since the crops failed the experiments were of little value. They proved this much, however, that the growth was decidedly more vigorous where a heavy dressing of caustic lime was applied. This was particularly the case on a piece of raw, peaty soil seeded to common oats. It was treated with 300 pounds muriate of potash to the acre, and a strip through the center was, in addition, treated with caustic lime at the rate of a ton to the acre. The limed strip produced a uniform and fair growth, while on the plats not limed the plants turned yellow and died.

Lime has been used sparingly because it is expensive. It costs here at Sitka $4.50 a barrel of 200 pounds. A ledge of limestone has been located some 14 miles from the station and a supply will be quarried during the winter. By the aid of the launch and scow, it can be hauled home and later burned for the needs of the station.

During the year considerable progress was made in extending the stock of fruit trees, bush fruits, ornamentals, etc., in the nursery.

The present condition and amount of growth of the different varieties are shown below:

### APPLES.

Duchess, 19 trees. May 2, uninjured by frost, buds swollen. October 10, 1 foot new growth, new wood very soft. This variety promises to do very well in this climate.

Red Astrachan, 18 trees. May 2, new wood one-third winterkilled. October 10, 3 inches new growth, not thrifty.

Yellow Transparent, 20 trees. May 2, tips killed. October 20, new growth 7 inches; trees look well. Wood too soft to withstand severe winter.

Maiden Blush, 16 trees. May 2, last year's growth killed back three-fourths. October 10, very poor, practically no new growth.

Early Harvest, 18 trees. May 2, tips killed back by cold. October 10, trees healthy, but only 2 inches new growth.

Raspberry, 18 trees. May 2, tips winterkilled. October 10, 4 inches growth. Gives fair promise.

Sylvan Sweet, 18 trees. May 2, tips killed, buds starting to open. July 1, 9 trees have good color, very little new growth. October 10, in fair condition for winter, 6 inches new growth.

Eureka, 19 trees. May 2, new wood killed back one-half. July 1, 4 trees dead, leaves small on remaining trees, very unthrifty. October 10, trees made fair growth; average 5 inches. In fair condition.

Tetofsky, 20 trees. May 2, tips injured. July 1, very backward: 3 inches growth. October 10, the growth on this variety for the season is not thrifty. Grew none after July 1.

Brier Sweet, 20 trees. May 2, tips killed. July 1, all trees nearly dead. No new growth October 10. Very poor, barely alive. No growth this season.

Lowell, 17 trees. May 2, last season's growth killed back one-half. July 1, 2 inches new growth. Trees look well October 10. Season's growth 5 inches; good promise.

Standard Hibernal, 3 trees. May 2, uninjured by cold. July 1, 2 inches growth. October 10, very thrifty. Season's growth, 16 inches.

Hyslop, 1 tree. May 2, tips injured, buds swelling. July 1, 1½ inches growth. October 10, vigorous looking. Season's growth, 6 inches.

Whitney Crab, 18 trees. May 2, tips killed. July 1, good color, 2 inches growth. September 1, 10 inches growth. October 10, season's growth, 12 inches. In fair condition for winter. Best of the crab apples.

Martha, 20 trees. May 2, uninjured, buds swollen. July 1, 4 trees unthrifty, others making some growth. October 10, average growth for season, 10 inches. Three of these trees will probably die before spring.

Transcendent, 3 trees. May 2, uninjured, buds swollen. July 1, 4 inches new growth. October 10, trees do not look very well. Very little growth since July 1.

These apples have made a very good showing under the adverse conditions. The new growth of last season did not harden up sufficiently to withstand the severe cold of the winter. The ground heaved badly when frozen, which caused the tearing and severe injury to the root system. This season has been an extremely wet and backward one for the trees to regain their normal vigor.

*Standard apples planted this season.*—Benoni, 5 trees, set July 1. All alive and in leaf. October 10, 6 inches growth.

Early Strawberry, 5 trees, set June 3. July 1, nearly in full leaf. October 10, 9 inches new growth; very promising.

Fanny, 5 trees, set June 3. July 1, in leaf. October 10, season's growth, 9 inches.

Golden Sweet, 5 trees, set June 3. July 1, coming out. July 16, in full leaf. September 1, 3 inches growth. October 10, 5 inches new growth. Promises to do well.

Primate, 5 trees, set June 3. July 1, coming out. July 16, in full leaf. September 1, 3 inches growth. October 10, 5 inches new growth.

Sops of Wine, 5 trees, set June 3. July 1, buds nearly open. July 16, nearly in full leaf. September 1, 2 inches growth. October 10, season's growth, 4 inches.

Summer Rose, 5 trees, set June 3. July 1, coming out. July 16, in leaf. September 1, 3 inches growth. October 10, season's growth, 5 inches; promises well.

Sweet Bough, set June 3. July 1, buds nearly open. July 16, in full leaf. September 1, 6 inches growth. October 10, season's growth, 12 inches. This variety made the strongest growth of the standard trees set this season.

Williams Favorite, 5 trees, set June 3. July 1, coming in leaf. July 16, leaf in full. September 1, 3 inches growth. October 10, growth for the season, 5 inches.

*Dwarf trees.*—Early Harvest, 3 trees, set June 3. July 1, buds opening. July 16, nearly full leaf. September 1, new growth, 4 inches. October 10, season's growth, 4 inches.

Fanny, 3 trees, set June 3. July 1, buds swollen. July 16, leaves nearly full grown. September 1, new growth, 4 inches. October 10, new growth for season, 6 inches.

Golden Sweet, 3 trees, set June 3. July 1, buds well advanced. July 16, in leaf. September 1, 3 inches new growth. October 10, season's growth, 4 inches.

Keswick Codlin, 3 trees, set June 3. July 1, buds swollen. July 16, leaves nearly full grown. September 1, 3 inches new growth. October 10, 4 inches season's growth.

Primate, 3 trees, set June 3. July 1, leaves coming out. July 16, in full leaf. September 1, 4 inches growth. October 10, 6 inches new growth.

Red Astrachan, 3 trees, set June 3. July 1, in leaf. July 16, in full leaf. September 1, average growth, 3 inches. October 10, average season's growth, 6 inches.

Tetofsky, 3 trees, set June 3. July 1, buds scarcely swollen. July 16, in leaf. September 1, no growth. October 10, 3 inches new growth.

Yellow Transparent, 3 trees, set June 3. July 1, buds well advanced. July 16, in full leaf. September 1, 3 inches growth. October 10, 4 inches new growth.

Sweet Bough, 3 trees, set June 3. In leaf July 1. July 16, in full leaf. September 1, 6 inches new growth. October 10, season's growth, 14 inches. Vigorous grower; gives good promise.

These varieties were planted in well-drained gravelly soil. Were received in good condition, and made a good start, considering season and lateness of planting.

*Apple grafts.*—Grafts of 1903: All new wood was killed back one-half. New growth this season averages 15 inches. Very tender for winter weather. June 1, Lowell on Wild Crab (crown), 2 coming in leaf. Lowell on Wild Crab (whip), 2 growing. Martha on Wild Crab (crown), 3 growing. Red June on Wild Crab (whip), 1 growing.

Apple grafts made in February from Alaska-grown scions on seedling stock: The wood of these scions was very soft and the seedling roots were 2 years old, making it very difficult to get the grafts to take. About 25 per cent grew. The growth was weak and the wood is not mature enough to stand severe freezing.

October 10, Maiden Blush 2, Red Astrachan 23, Duchess 16, Raspberry 20, Yellow Transparent 15, Red June 1, Sylvan Sweet 36, Eureka 1, Martha 28, Whitney 20, Early Harvest 16, Whitney on Native Crab 4.

Scions from Iowa Experiment Station: Ninety-seven per cent of these grafts grew. Northwest Greening 2, Northwest Greening on Native Crab 1, Malinda 1, Hibernal 7, Wealthy 5, North Star 5, Walbridge 4, Patten Greening 5, Princess Louise 8, Ansim 7, Okabena 3, Brier Sweet 5, and Green Sweet 2.

Apple grafts received from Jewel Nursery, Lake City, Minn.:

Bode, 50 received, 49 grew; Hibernal, 50 received, 42 grew; Longfield, 50 received, 49 grew; Lyman Prolific, 50 received, 34 grew; Jewel Winter, 20 received, 10 grew; Minnesota, 20 received, 10 grew; Virginia, 20 received, 9 grew; Wealthy, 50 received, 44 grew; Yellow Transparent, 50 received, 49 grew.

Received from Yankton Nursery, Yankton, S. Dak.:

Peerless, 7 trees, set May 5. June 15, in full leaf. July 1, all growing nicely. August 15, 4 inches new growth. October 10, look well; grown little since August 15.

Duchess, 8 trees, set May 5. June 15, in full leaf. July 1, growing thriftily. August 15, new growth 6 inches. October 10, season's growth 8 inches. Trees thrifty.

Wealthy, 6 trees, set May 5. June 15, not quite in full leaf. July 1, all growing. August 15, 3 inches new growth. October 10, season's new growth 5 inches.

Patten, 7 trees, set May 5. June 15, in full leaf; growing. July 1, very good growth; thrifty. August 15, 4 inches growth. October 10, looks well, but has grown but little since August 15.

Hibernal, 7 trees, set May 5. June 15, all growing. July 1, 3 inches new growth. August 15, 10 inches growth. October 10, season's growth 13 inches; very promising.

Jessie, 7 trees, set May 5. June 15, all growing. July 1, 3 inches growth. August 15, 12 inches growth. Very thrifty. October 10, season's growth 14 inches.

June Berry, 13 plants. May 2, uninjured by frost, buds well advanced. July 1, very thrifty, 3 inches growth, in bloom. September 1, some fruit, coloring up slightly, new shoots 15 inches long. October 10, thrifty, season's growth 18 inches; some fruit matured.

### CHERRIES.

English Morello. May 2, one-third last year's growth winterkilled, 12 trees alive. June 1, very backward. July 1, 10 trees alive, but 1 vigorous. September 1, average growth 5 inches.

Ostheimer, 15 trees. May 2, tips winterkilled. June 1, buds well advanced. July 1, backward; more vigorous than English Morello; 2 trees in bloom. September 1, average growth 6 inches. October 10, average growth 8 inches. Trees vary greatly in growth; no fruit set.

Early Richmond, 19 trees. May 2, new wood killed back one-third. June 1, buds barely begun to swell. July 1, all growing; not vigorous. September 1, average new growth 12 inches. October 10, season's growth 15 inches. This variety came out and is the most promising of any at close of this season.

Dyehouse, 19 trees. May 2, tips winterkilled. June 1, buds well advanced. July 1, all growing very slowly. September 1, 5 inches new growth. October 10, trees look very well. Season's growth averages 7 inches.

Cherry grafts from Jewel Nursery, Lake City, Minn.: 20 Surprise planted, 4 lived; 20 Compass planted, 20 lived.

### PLUMS.

Forest Garden, 10 trees. May 2, new wood all killed. June 1, lower buds alive; begun to swell. July 1, 9 trees started new growth, very backward. September 1, new shoots 12 inches long. October 10, new growth very spindling; too tender for winter weather.

Hawkeye, 10 trees. May 2, all last year's growth winterkilled. June 1, buds swelling. July 1, some growth; leaves very yellow; unthrifty. September 1, new growth 12 inches; very tender. October 10, 7 trees very poor; will probably die.

Red June, 8 trees. May 2, last year's growth all killed, trees badly injured. June 1, lower buds show life. July 1, few leaves; very yellow. September 1, new growth 12 inches; poor. October 10, season's growth 15 inches. While this variety made the greatest growth, it will hardly survive the winter.

De Soto, 9 trees. May 2, last year's wood all dead. June 1, lower buds show life. July 1, very poor; leaves yellow. October 10, season's growth 12 inches. Very poor promise.

The plums were more severely injured by the cold than were the other kind of trees.

May Day, 4 trees, set May 18. July 1, growing nicely. September 1, 8 inches new growth. October 10, season's growth average 10 inches. Trees small, but thrifty.

Bixby, 2 trees, set May 18. July 1, doing well. September 1, very slow growing. October 10, 2 inches growth. Very poor.

Sayles, 2 trees, set May 18. July 1, growing very well. September 1, new growth 12 inches. October 10, season's growth averages 15 inches. Trees vigorous.

Rollingstone, 1 tree, set May 18. July 1, making fair growth. September 1, new growth 2 inches. October 10, 3 inches new growth. Unthrifty.

Wyant, 2 trees, set May 18. July 1, making good growth. September 1, new shoots 12 inches long. October 10, season's new growth average 15 inches. Very thrifty.

Tomahawk, 1 tree, set May 18. September 1, leaves good color; no growth. October 10, very little growth; looks well.

Fifty grafts Aitkin, planted May 25, 22 growing; 20 grafts Rollingstone, planted May 25, 19 growing.

Grafts from scions received from the Iowa Experiment Station. Only 25 per cent of these grafts grew.

Mankato 1, Ames 1, Hunst 1, Wolf 1, Odegard 1, *Prunus besseyi* on Plum 3, Bestovall 1, Beatty 1.

These scions were put on piece roots taken from trees that had been killed back during winter. The roots were too old to be successfully grafted.

### BUSH FRUITS.

*Blackberries.*—The station has a few bushes of Turner, Fuller, Colorado, Snyder, and Taylor. The canes of each were winterkilled to the ground last year. The growth was thrifty this season, many of the canes being 3 feet long. To produce fruit the blackberry will probably need winter protection in this climate.

*Raspberries.*—Exposed bushes of the variety common to the gardens about the town (Cuthbert?). Bushes somewhat protected bore well, but somewhat later than normal. We have a large number of this variety for distribution.

The canes of both Miller and Loudon were winterkilled to the ground. Made good growth this season, having canes 4 feet long.

This season a few bushes of each variety were added to the stock. Champlain, Superlative, and Orange. These were in poor condition when received and made but little growth this season.

*Currants.*—Currant bushes made a very good growth this season, but produced little fruit. The clusters were not well filled, and the berries were under size.

Fay Prolific. No winter injury. June 1, full leaf and bloom. September 1, new wood 18 inches long; very little fruit. October 10, season's growth 2 feet; wood well hardened.

Victoria, 2 plants. June 1, in bloom. September 1, fruit ripe; larger berries than other varieties. Two feet new growth. October 10, wood in good condition.

Ruby Castle, Manitoba Amber, and Crandall developed about equal to the previous-named varieties, except that they produced no fruit.

There was added to the list this season 10 plants each of Black Champion, Lee Prolific, Red Cross, and Wilder. These were in bad condition when received and were slow starting. Average growth, 6 inches.

There are about 1,200 plants started from cuttings this spring. These are to be distributed.

*Strawberries.*—The past winter was a severe one on strawberry plants, because of the heaving of the ground. The beds were covered with spruce boughs, but not heavy enough to prevent the freezing of the soil, the snowfall being unusually light.

The station has a few plants of Bismarck, Lady Thompson, Enhance, Excelsior, Saunders, and Haverland. The Bismarck came through the winter in the best condition of the tame berries. The wild native berries were not injured by the winter weather. The native plants are prolific growers and bloom well, but the flowers are imperfect. The tame and wild plants were set in alternate rows last year with hopes that they would cross-fertilize, and thus we might get berries on the wild species. The tame varieties produced but few blooms this season, but a few berries were gathered from the wild vines, which are undoubtedly from bloom cross-fertilized. It is hoped we can start plants from this seed.

*Cranberries.*—The few plants received from Wisconsin and set in spring of 1903 came through the winter in fair condition and have made some growth this season. A few plants were received this summer and planted out, but it is doubtful if these have started enough to survive the winter.

The native Alaskan cranberry (*Vaccinium vitis-idæa*) set out this spring has made excellent growth and gives promise of yielding well to cultivation. The *Oxycoccus oxycoccus* set out last year died during the winter. No new plants have been set this season. They do not promise to be prolific bearers. Seed of eastern berries planted in flats doing nicely.

*Gooseberries.*—A few bushes of gooseberries are being grown. The varieties are uncertain, having been obtained from the gardens of Sitka. They grew well this season. We have 100 young plants grown from cuttings of these bushes.

This spring were planted 10 each of Industry, White Smith, Columbus, Red Jacket, Smith Imperial, and Triumph. These were in bad shape when received. Only about half grew.

### ORNAMENTALS.

Bittersweet Creeper, 1 plant. Tips winterkilled. June 1, buds swelling. July 1, leaves yellow; very little growth; bloom buds swelling. October 10, nearly dead; will not survive the winter.

Lonicera alba rosa, 3 plants. May 2, buds swelling. June 1, full leaf. July 1, 4 inches new growth; bloom buds swelling. October 10, does not look well.

Siberian wild olive, 2 plants. June 1, buds beginning to show life. July 1, very poor. October 10, will probably not survive the winter.

Sand cherry, plant uninjured by cold. June 1, well advanced. July 1, not thrifty. October 10, season's growth 4 inches. Poor condition.

During the season the following ornamentals have been set up in the nursery: 1 *Spiræa salicifolia*, 1 caragana, 1 *Spiræa van houtii*, 10 common lilac, 1 white lilac, 1 purple lilac, 1 *Spiræa sorbifolia*, 1 Tartarian honeysuckle, 1 hydrangea, 1 *Spiræa aurea*, 1 high bush cranberry, 1 *Rhamnus typhina*, 1 *Berberis vulgaris*, 100 Buffalo berry, 1 *Lonicera tartarica*, and 10 Eglantine and 10 *Rosa rugosa*. Most of the plants have done very well this season considering the conditions of the weather.

### VEGETABLES.

*Beans.*—Broad Windsor, seeded June 1. June 11, germinated well; strong plants. July 1, 5 inches high. July 15, 8 inches high; good color. August 15, in bloom. September 16, pods 2 inches long. The plants were killed by frost September 23, before the beans were large enough for use.

*Vicia faba*, seeded June 7. Varieties Nos. 10433 and 10541 were up June 20. Nos. 10426, 10439, 10440, and 10442 came up June 26. No. 10443 came up June 28. Nos. 10423, 10444, and 10445 very backward. Other varieties doing very well, 3 inches high. August 15, all varieties in bloom. September 16, No. 10433 2 feet high, few blossoms; No. 10439 2 feet high, full of bloom; No. 10440 15 inches high, full of bloom; No. 10442 15 inches high, plants dead; No. 10443 18 inches high, lower leaves and bloom dead; No. 10444 18 inches high, bloom dead; No. 10445 18 inches high, plants thrifty, no bloom; No. 10446 2 feet high, some bloom, few pods set; No. 10536 full bloom; No. 10540, some bloom, few pods set; No. 10541, bloom dead, leaves turning yellow. The growth of these plants was checked by frost September 23.

Early Refuge, seeded June 1, were very backward and irregular in germinating; plants very weak and unthrifty; all died.

Early Mohawk, Extra Early Red Valentine, and Extra Early Challenge Black Wax, germinated and grew as did the Early Refuge; very few plants produced second leaves.

*Beets.*—Extra Early Eclipse Blood Turnip, seeded May 23. Germinated June 14. July 16, growing very slowly. August 15, growth very slow, sending up seed stalks.

Dark Red Turnip, seeded May 23. Came through the ground June 11, growth very slow. August 15, small, sending up seed stalks.

Crimson Globe, seeded May 23. Broke ground June 13. Acted same as other varieties.

*Brussels sprouts.*—Dwarf Improved, seeded in hotbed May 12, germinated May 18. June 1, plants making slow growth; seeded in open ground. Plants from hotbed reset to open ground May 28. July 1, making very slow growth. August 15, very little growth, no promise of developing sprouts.

*Cabbage.*—Danish Ball Head, seeded in hotbed April 25, germinated April 30. June 1, most advanced of any variety in the bed. Seed planted to open ground. June 10, plants reset from hotbed to open ground. July 16, plants seeded in open ground; growing slowly. Those transplanted show effect of cold by turning purple. August 15, no promise of heading.

Early Jersey Wakefield, seeded in hotbed April 25. In open ground June 1. Plants nearly equal to Danish Ball Head; not vigorous. June 15, seed in open ground germinated; June 10, plants transplanted to open ground from hotbed. July 16, plants seeded in open ground growing very slowly; those transplanted seem in better condition than those of any other variety. August 15, none heading.

Extra Early Express, seeded in hotbed April 25, germinated May 4. Seeded in open ground May 31, germinated June 15. Plants transplanted from hotbed June 10. Plants not so strong as those of other varieties. Plants seeded in open ground July 16, growing very slowly. Those transplanted nearly all dead.

Early Dwarf Flat Dutch, seeded in hotbed April 25, up May 2. Seeded in open ground May 31, up June 15. Transplanted to open ground June 10. July 16, this variety seems to withstand transplanting best. August 15, none heading.

Improved Stonemason, seed did not germinate.

Henderson Early Summer, seeded in hotbed April 25, came up May 2. Seeded in open ground May 31, came up June 15. Germinated very poorly, transplanted June 10. July 16, plants very poor; those seeded in open ground equal to those set from hotbed. August 15, none heading.

Large Late Flat Dutch, seeded in hotbed April 25, germinated May 2. Seeded in open ground May 31, germinated June 16; transplanted from hotbed June 10. July 16, plants very poor. August 15, none heading.

Premium Drum Head, seeded in hotbed April 25, germinated May 2. Seeded in open ground May 31, came up June 16. Plants transplanted to open ground June 10. Very little growth. August 15, none heading.

*Cauliflower.*—Snowball, seed from Denmark, seeded in hotbed April 25, germinated April 30. Seed germinated poorly; small percentage of plants grew; transplanted to open ground June 10; grew very little; developed no flowers.

*Carrot.*—Scarlet Horn, seeded May 25, came up June 13. July 16, 1½ inches high, good stand, growth slow. August 15, practically no growth since July 16; sending up seed stalks.

Oxheart, Long Stump Rooted, and Chantenay developed the same as did Scarlet Horn. All seeded and germinated the same dates.

*Celery.*—Golden Self Blanching, seeded in hotbed April 25, germinated May 20. June 15, making slow growth. July 16, plants transplanted to open ground. July 30, plants set in open ground nearly all dead; plants left in hotbed growing nicely. August 30, plants in hotbed doing well, 12 inches high. September 15, 15 inches high; very good in quality.

*Kale.*—Dwarf Green Curled Scotch, seeded in hotbed April 25, up April 30. June 1, plants thrifty. Transplanted to open ground June 10; plants grow very slowly. August 15, many plants sending up seed stalks.

Dwarf German, seeded in open ground May 20, germinated June 1. July 1, growing nicely. August 15, very good. September 1, is much larger than varieties seeded in hotbed.

Tall Green Curled Scotch, seeded in open ground May 20, germinated June 1. July 1, doing nicely, plants vigorous. August 15, very good. September 15, best planted this season.

*Lettuce.*—Big Boston, seeded in hotbed April 25, came up June 2. June 15, doing splendidly. Seeded in open ground May 20. July 1, very poor. August 15, plants in open ground sending up seed stalks. Plants in old hotbed are excellent.

Other varieties seeded in hotbed and open ground were Morse, Philadelphia, and California Cream Butter. These developed about as did Big Boston.

*Parsley.*—Early Curled, seeded May 30, up June 15, grew very slowly. August 15, sending up seed stalks. Very poor.

The other variety seeded was Plain or Single. This did no better than the former.

*Peas.*—Alaska, seeded May 21. June 1, up. Good stand July 1, 5 inches high. July 16, 12 inches high. July 30, in bloom. First picking September 10. This variety did not bear as heavy as some of the others, but was a few days earlier, and the flavor was superior to that of the other varieties seeded.

First and Best, seeded May 20. June 3, up, good stand. July 1, 6 inches high. July 30, in bloom. First picking September 16. This variety gave the heaviest yield of any other variety seeded.

Prolific Early Market, seeded May 21, up June 3, stand good. June 30, 6 inches high. July 16, 12 inches high. First picking September 16.

Premium Gem, seeded May 21. June 5, up, good stand. July 1, 4 inches high. July 16, 6 inches high. First picking October 4.

*Potatoes.*—Mills Stock, planted May 12. July 1, breaking ground. July 16, good color, but grew very slowly. July 30, average 6 inches high. Dug October 8–9. Less than one-fourth of a crop, 50 per cent small ones.

Garfield, planted May 12. July 1, breaking surface. July 16, good stand. Very slow growth. July 30, 6 inches high. Dug October 7; 25 per cent small ones. One-fourth crop.

Freeman, planted May 13. July 1, very few plants coming up. July 16, stand very poor. July 30, average height 4½ inches. Very few potatoes set.

Kenai Stock (white), planted May 13. July 1, breaking ground. July 16, poor stand. July 30, average height 5 inches. Dug October 7. Almost a failure.

Kenai Stock (red), planted May 13. July 1, coming up. July 16, stand fair. July 30, average height 5 inches. Dug October 6. Failure.

Other varieties of which a few were planted were Early Ohio, Extra Early Ohio, Bovee, Carman No. 3, Extra Early Triumph, and Hamilton Early.

A few were started in boxes placed in the hotbed and then transplanted to the open ground. These gave no better results than those started in the open. They were planted on our warmest ground and produced a few potatoes ranging in size from hazelnuts to walnuts.

*Rhubarb.*—Planted July 1. This grew well throughout the season. The older roots grew very poorly, due, perhaps, to location.

*Ruta-baga.*—Purple Top Yellow Swede, seeded May 19. June 13, up, good stand. July 1, second leaves just forming. August 15, growing very slowly, seed stalks forming. September 15, roots the size of teacups and many plants running to seed.

Other varieties seeded were Champion and Yellow. These developed the same as the Purple Top. The same varieties seeded three weeks later produced the same results.

*Sage.*—Twenty-five per cent of the plants survived the winter. June 15, growing nicely. August 15, in bloom. No seed developed.

*Turnips.*—Only the White Strap Leaf was seeded. This did not develop normally, grew very slowly, and sent up seed stalks.

### GRASSES (THIRD SEASON'S GROWTH).

Meadow foxtail (*Alopecurus pratensis*).—June 1, very good stand, 4 inches tall. June 15, in bloom, some of the stalks 2 feet tall. September 1, seed in dough, but the growth very light. October 1, seed ripe.

Tall meadow oat grass (*Avena elatior*).—June 1, stand good, 6 inches tall. July 1, heading from 2 to 4 feet, very good. September 1, seed in dough and beginning to ripen. This is the best of our tame grasses, judging from its behavior here.

Kentucky bluegrass (*Poa pratensis*).—June 1, very thin stand, 4 inches high. July 1, in full head but light growth, 1 foot high. September 1, seed ripe, but apparently of poor quality. Bluegrass does not do as well here as in warmer regions.

Tall meadow fescue (*Festuca elatior*).—June 1, very poor stand and new growth spindling. July 1, continues poor, plants turning yellow, some heading, 15 inches tall. October 1, seed ripe. Its behavior here does not promise well for its usefulness.

Redtop (*Agrostis vulgaris*).—June 1, good stand, but scarcely any growth. August 15, in bloom, best 2 feet, but a light growth. September 1, seed nearly ripe. Is not promising.

Timothy (*Phleum pratense*).—Stand very thin and but little growth. July 1, 15 inches tall, beginning to head. August 15, in bloom, heads very short, and growth light. September 1, seed just forming. October 1, some seed ripe and some will fail to ripen.

Orchard grass (*Dactylis glomerata*).—June 1, stand very poor, but some of it 6 inches tall. July 1, heading, seed stalks 2 feet. August 15, in bloom. October 1, some seed ripe. This is the third year, and none of the grasses was as vigorous as last year.

White clover is perennial and will spread in door yards and grass plats wherever it gets a start. Red clover winterkilled.

## WORK AT KENAI STATION.

Work has been continued at the Kenai Station along the lines followed in former years. Twenty-one acres were under culture the past season, and 3½ acres more were cleared, broken, and fenced during the summer, making a total area of 24½ acres available for culture next year. This last clearing was made in the woods, so as to leave a heavy shelter belt of timber as a protection to the crops against the winds from the inlet. Aside from the testing of many varieties of grain, vegetables, grasses, and forage plants, the details of which are given in Mr. Ross's report submitted herewith, every variety of grain was grown on plats fertilized with superphosphate at the rate of 300 pounds to the acre. The purpose was to ascertain the influence of this fertilizer, first, on the growth of the crop, and, secondly, to ascertain if it would hasten maturity. The results show a very decided increase in growth on the fertilized plats, but there was but little proof that it hastened the development of the grains.

The season was so cold and backward that none of the grains matured. A killing frost occurred August 26, when most of the grain was still in the dough state. It is not surprising that grain should fail to mature at Kenai, since it failed everywhere else in the entire coast region. The grain was cut for hay, and produced a large yield of fine quality. The failure to mature gives emphasis to the surmise expressed in former reports that the region is better adapted to stock raising than to grain growing. Early varieties of barley and oats can be matured in sheltered positions in favorable years, but our experience at this station is decidedly unfavorable to the idea that the region bordering Cook Inlet is adapted to profitable grain growing. Forage can be grown to an unlimited extent. The grasses and other forage plants have also done well; so there is no doubt about the adaptability of the region for the production of stock feed.

The station now owns 10 head of live stock, 4 of which are milch cows, 3 calves, and 3 work oxen. One of the latter is so old and decrepit that he will not be wintered. The cows have all been reared at Kenai, and are therefore thoroughly accustomed to the conditions, having been fed exclusively on forage produced there. From their milk record, given in Mr. Ross's report, it will be seen that for native cows they are not bad milkers. Bourka, a cow in her prime, yielded 5,437 pounds of milk in two hundred and sixty-eight days without any grain whatever. The other three cows yielded less, but they are all young, and will doubtless do better in coming years.

As soon as funds can be had for the purpose some 8 or 10 head of good dairy cows should be added to this station, so as to enable us to undertake dairy experiments on a small scale. Mr. Ross has made small amounts of butter from the four cows now at the station, but is without adequate utensils. It is hoped to provide a hand separator and other necessary utensils this coming spring.

The stations in the Copper River Valley and at Rampart should have the first consideration until they are so far developed as to be able to practice farming on a scale comparable with that of the average farmer in the States. This development work is very expensive. As noted elsewhere, labor costs $6 a day on the Yukon and $5 a day at the Copper Center Station, so that unless we have a special appropriation for live-stock experiments the funds will not permit of the purchase of dairy cattle for the Kenai Station.

## REPORT OF P. H. ROSS, SUPERINTENDENT OF KENAI STATION.

KENAI, ALASKA, *September 19, 1904.*

DEAR SIR: I have the honor to make the following report for the season of 1904:

### WEATHER CONDITIONS.

The season opened very favorably. The snow was entirely gone by April 24, and the plowing began May 2. The frost was not entirely out of the ground at that time, but the soil was thawed to a sufficient depth to start the plow. The spring proved very dry, rain not falling in measurable quantities at any time during the month of May. For twenty days of the month a cold southwest wind retarded the growth of crops. During the month of June 0.87 inch of rain fell, and for nineteen days the wind was in the southwest. Up to August 7 the highest temperature reached was 65° F. In short, it is the driest and coldest growing season, with the earliest severe frost recorded by the station. From the reports of old settlers it is the most unfavorable ever known in the Cook Inlet country. One remarkable feature of the season was the practically total absence of mosquitoes.

### CLEARING LAND.

In addition to the care of grain, grasses, and forage crops on the 21 acres already cleared, 3½ acres have been cleared, broken, and fenced. This new clearing is well back in the woods, with a broad belt of timber giving it good protection from the winds of the inlet. It has a southeastern slope which affords good exposure to the sun and good drainage. There is every reason to believe that all crops will do much better on this ground than on the ground already cleared.

### FERTILIZER EXPERIMENTS.

Two-thirds of an acre of ground was plowed, and fertilized with superphosphate, sown broadcast at the rate of 300 pounds to the acre. The fertilizer was then harrowed in. This plat was seeded to every variety of grain on hand. A similar plat near by was seeded in the same way, but without fertilizer. The results show that the fertilized soil produces a much more even, uniform, and rank growth, and consequently a heavier yield of grain.

*Burt Extra Early oats.*—Seeded May 12 in both plats. June 1, just coming up in both plats. June 15, stand good, 3 inches high in both plats. July 1, fertilized, 6 inches high; unfertilized, 4 inches high. July 15, fertilized, 12 inches high; unfertilized, 6 to 10 inches high. August 1, fertilized, uniformly 24 inches high, fully headed; unfertilized, 12 to 24 inches high, 90 per cent headed. August 15, fertilized, 36 inches high, some in bloom and some in milk; unfertilized, 24 to 36 inches high, ranker spots in bloom. September 1, fertilized, 40 inches high, grain in dough, shriveled and watery from frost of August 26; unfertilized, in about the same condition.

*Hulless barley.*—Seeded May 12 in both plats. June 1, just up with good stand in both plats. June 15, stand heavy, 3 inches high in both plats. July 1, fertilized, 12 inches high; unfertilized, 4 to 8 inches high. July 1, fertilized, 14 inches high, a few heads showing; unfertilized, 4 to 14 inches high, 70 per cent yellow and stunted, no heads. August 1, fertilized, 30 to 36 inches, headed and in bloom; unfertilized, 50 per cent headed and in bloom. August 15, fertilized, average 36 inches high, uniformly in dough; unfertilized, 12 to 40 inches high, rank spots in dough. September 1, fertilized, 40 to 48 inches high, well advanced in dough, grain shriveled by frost; unfertilized, 24 to 40 inches high, rank spots still in dough, injured by frost.

*Beardless barley.*—Seeded May 12. June 1, just coming up in both plats. June 15, heavy stand, 4 inches high in both plats. July 1, fertilized, 6 to 12 inches high; unfertilized, 4 to 8 inches high. July 15, fertilized, 10 to 14 inches, quite a number of heads showing; unfertilized, 4 to 14 inches, 30 per cent yellow and stunted, a very few heads. August 1, fertilized, 30 to 36 inches high, headed and in bloom; unfertilized, 12 to 36 inches high, 90 per cent headed and in bloom. August 15, fertilized, average 36 inches high, uniformly in dough; unfertilized, 12 to 40 inches high, rank spots in dough. September 1, fertilized, 36 inches high, well advanced in dough, grain shriveled by frost, leaves turning yellow.

*Corn-wheat.*—Seeded May 12. June 1, just coming up in both plats. June 15, 3 inches high, good stand in both plats. July 1, fertilized, 6 inches high; unfertilized, 4 inches high. July 15, fertilized, 12 inches high, uniform; unfertilized, 6 to 10 inches high, spindling growth. August 1, fertilized, 30 to 40 inches high, 90 per cent headed; unfertilized, 12 to 30 inches high, 50 per cent headed. August 15, fertilized, in milk and small percentage in dough; unfertilized, 24 to 36 inches high, in milk. September 1, failed to fill in both plats.

*Common oats.*—Seeded May 12. June 1, just coming up in both plats. June 15, heavy stand, 3 inches high in both plats. July 15, fertilized, 6 to 14 inches high; unfertilized, 6 to 10 inches high. August 1, fertilized, a narrow strip running the whole length of the plat at one edge is dark green in color and averages 36 inches in height. The remainder of the plat is about 18 inches high and is of a yellow, unhealthy color; unfertilized, 12 to 36 inches, dark green. August 15, fertilized, headed and partly in bloom; unfertilized, 20 to 36 inches high, none in bloom. September 1, fertilized, 40 to 48 inches high, some in milk and some in dough when killed by frost of August 28; unfertilized, about the same.

Another plat was seeded to barley and part of each plat fertilized with kainit at the rate of 500 pounds to the acre. The fertilizer had no apparent effect on the growth of the grain.

*White Hulless barley.*—Seeded May 12. June 15, stand good, 3 inches high. July 1, growth spotted, yellow, and unthrifty. July 15, 4 to 14 inches high. August 1, 12 to 36 inches high, rank spots headed and in bloom. August 15, 20 to 30 inches high, rank spots in dough. September 1, further advanced in dough but shriveled by frost.

*Beardless barley.*—Same results as above.

### VALUE OF SHELTER BELTS.

*Common oats.*—The greater part of the ground under cultivation was seeded to field oats. The benefit of a belt of timber in neutralizing the effect of the inlet winds is very strikingly shown this season. Field A is situated just back of the village, fully exposed to the southwest wind. Field B is protected on all sides by timber. Following are the notes of the growth on each field:

Field A, seeded on May 21. Field B, seeded May 20, 23, and 24. June 15, Field A, stand good, 2½ inches high; Field B, stand good, 3 inches high. July 1, Field A, 4 inches high; Field B, 4 to 6 inches high. July 15, Field A, 6 to 10 inches high; Field B, 6 to 10 inches high. August 1, Field A, 12 to 18 inches high, a few heads; Field B, 24 to 30 inches high, no heads. August 15, Field A, 26 inches high, fully headed; Field B, 36 inches high, beginning to head. September 3, Field A, 30 inches high; Field B, 40 to 48 inches high. Will be cut for hay as soon as weather permits.

### WINTER GRAIN.

On August 18 and 19, 1903, the following winter grains were sown: Winter wheat, Yarasloff wheat, Excelsior, Schlansted, and Techitin rye. Only the Winter wheat and Excelsior rye survived the winter. Following are the notes:

*Winter wheat.*—May 16, 3 inches high, growth spotted. June 1, no growth. June 15, 3 to 18 inches high. July 1, 6 to 36 inches high, some heads appearing. July 15, headed out, 18 to 40 inches high. August 1, 18 to 50 inches high, a small percentage in bloom. August 15, a small percentage in milk, the remainder in bloom. Some in bloom, some in milk, and some in dough when killed by frost of August 26.

*Excelsior winter rye.*—May 16, 3 inches high. June 15, 12 to 18 inches high, some heads showing. July 1, 40 inches high, fully headed. July 15, 40 to 56 inches high. August 1, 40 to 60 inches high, small percentage in bloom. August 15, partly in dough stage. Killed by frost August 26.

### VEGETABLES.

*Cabbage.*—Large Early York and Early Jersey Wakefield planted in hotbed April 25. Large Late Flat Dutch, Henderson Early Summer, and Improved Stonemason planted in hotbed May 1. The two latter failed to germinate. The Large Late Flat Dutch is too late and will not head this year. Early Jersey Wakefield and Large Early York were transplanted to open ground June 9. The spring being very dry and backward, they did not begin to grow well until the 1st of August. They are heading at the present time and will probably make fair-sized heads. Many plants were killed by the insect popularly known as the cabbage maggot.

*Cauliflower.*—Extra Early Paris seeded in hotbed April 25. Transplanted to open ground June 8. All plants killed by cabbage maggot.

*Parsley.*—Extra Curled seeded in hotbed April 25. Was not removed from hotbed and made a splendid growth 12 inches high.

*Onions.*—Extra Early Brown Spanish seeded in hotbed April 25. Remained in hotbed, producing onions about three-fourths of an inch in diameter. Onion sets placed in the ground May 13 attained a size of 2 inches in diameter.

*Lettuce.*—Big Boston and California Butter seeded in hotbed April 25. As the other plants were removed the lettuce was transplanted to their place in the hotbed. Both varieties did very well, forming large, compact heads, crisp and tender.

*Celery.*—Improved White Plume seeded in hotbed April 25. The plants made but a poor, sickly growth.

*Radishes.*—Early Scarlet Turnip and French Breakfast seeded in hotbed April 25. Ready for table use May 31.

*Kale.*—Tall Curled Scotch seeded in hotbed April 25. Transplanted to open ground June 8. Grew well from the first, and at present some plants are 15 inches in height and measure 36 inches from tip to tip of the leaves.

*Beans.*—Extra Early Challenge, Black Wax, Broad Windsor, Extra Early Red Valentine, Giant Stringless, and Green Pod Valentine were seeded. None of these beans attained a size of over 3 inches in height except the Broad Windsor, which grew to a height of 2 feet, coming into bloom August 1. A few pods had formed by August 26, when growth was stopped by the frost.

*Peas.*—Alaska and Prolific Early Market seeded in open ground May 13. Came into bloom August 1. Peas large enough for use August 25. Both varieties did equally well as to earliness, with the Alaska bearing somewhat heavier than the Early Market.

*Beets.*—Extra Early Eclipse Blood Turnip and Crimson Globe seeded in open ground May 13. Both varieties did very poorly, attaining a size of 2 inches in diameter.

*Carrots.*—Scarlet Horn and Half Long Stump Rooted seeded in open ground May 13. At present both varieties are about 1 inch in diameter and are still growing.

*Spinach.*—Long Standing seeded in open ground May 14. Ran to seed almost immediately after coming up.

*Parsnips.*—Early Round seeded in open ground May 14. Will not become large enough for use.

The Rhubarb was large enough for use May 31 and remained tender and juicy until September 1.

*Sugar beets.*—Elite Kleinwanzleben. Part of the seed was grown in Germany and part in Nebraska, but no difference was apparent in results. Two plats were seeded, one in Field A and one in Field B. Field A, which is exposed to the southwest winds, produced nothing. In Field B the beets attained a size of 2 inches in diameter. Some of the plants are running to seed.

### FORAGE CROPS.

*Canadian field peas.*—Seeded May 20. June 15, stand good, 2 inches high. July 1, 4 to 6 inches high. July 15, 6 to 12 inches high . August 1, vines 30 inches in length. August 15, vines 40 inches in length, in bloom. September 1, vines 4 feet long, no pods formed. Cut for hay September 7.

*Rape.*—Seeded May 27. June 15, just coming up. July 4, stand good, 1 inch high. July 15, 2½ inches high. August 1, 6 to 12 inches high. August 15, 6 to 18 inches high. Cut September 5. The plat was exposed to southwest winds.

*Spring vetch.*—Seeded May 27. June 15, just coming up. July 1, stand good, 1 inch high. July 15, 2½ inches high. August 1, 6 inches high, spreading. August 15, 12 inches high. September 1, 24 inches high, a few blossoms. Cut September 7.

*Hairy vetch.*—Seeded May 27. June 15, just coming up. July 1, stand good, 1 inch high. July 15, 2 inches high. August 1, 4 to 6 inches high, spreading. August 15, no growth. September 1, 12 to 20 inches high. Cut September 7.

*Alfalfa.*—Seeded May 27. July 1, 1 inch high, true leaves developing. July 15, 1½ inches high. August 1, 4 inches high. August 15, 4 to 9 inches high. September 1, 4 to 12 inches high.

### GRASSES SEEDED IN 1902.

*Agrostis vulgaris.*—June 1, 3 inches high. June 15, 4 inches high. July 1, 6 inches high. July 15, 18 inches high, headed out. Cut for hay July 23.

*Dactylis glomerata.*—June 1, 2 inches high. June 15, 3 to 6 inches high. July 1, 6 inches high, looks unthrifty. July 15, 24 inches high, headed out. Cut for hay July 23.

*Alopecurus pratensis.*—June 1, 3 to 6 inches high, beginning to head. June 15, 12 to 16 inches high. July 1, 30 inches high. July 15, 30 inches high. Cut for hay July 23.

*Phleum pratense.*—June 1, 4 inches high. June 15, 6 inches high. July 1, 8 inches high. July 15, 12 to 18 inches high, heading out. Cut for hay July 23.

*Bromus inermis.*—June 1, 5 inches high. June 15, 8 inches high. July 1, 12 inches high. Cut for hay July 23.

*Festuca elatior.*—June 1, 3 inches high. June 15, 5 inches high. July 1, 6 to 12 inches high. July 15, 24 to 30 inches high. Cut for hay July 23.

### GRASSES SEEDED IN 1903.

Of the grasses seeded in 1903, the following were winterkilled: *Avena elatior* and *Lolium perenne.* The notes on the remainder are as follows:

*Bromus inermis.*—June 1, 3 inches high. June 15, 6 to 12 inches high. July 1, heavy uniform growth, 15 inches high. July 15, 20 to 30 inches high.

*Alopecurus pratensis.*—June 1, 2 inches high. June 15, 12 to 16 inches high. July 1, 20 inches high. July 15, 24 inches high, in bloom.

*Phleum pratense.*—June 1, 2 inches high. June 15, 4 inches high. July 1, 6 inches high. July 15, 12 inches high, heading out.

*Festuca elatior.*—June 1, 3 inches high. June 15, 3 to 6 inches high. July 1, 12 to 18 inches high. July 15, 24 inches high, heading out.

*Agrostis vulgaris.*—June 1, 2 inches high. June 15, 4 inches high. July 1, 6 inches high. July 15, 8 inches high.

White and Alsike clovers made a slow, unhealthy growth, reaching a height of 12 inches. Both will mature some seed.

All the above grasses, but not the clovers, were cut for hay July 23.

One-half of each of the grass plats seeded in 1902 and 1903 were sown with land plaster May 27. No effect whatever was noted in any of the plats.

### GRASSES SEEDED IN 1904.

*Festuca pratensis.*—Seeded May 27. July 1, heavy stand, 1 inch high. July 15, 3 inches high. August 1, no growth. August 15, 4 to 6 inches high. September 1, 6 inches high, no seed formed.

*Poa pratensis.*—July 1, 1 inch high. July 15, 3 inches high. Made no further growth during the season.

*Lolium perenne.*—July 1, 2 inches high. July 15, 3 inches high. August 1, 4 inches high. August 15, 6 inches high. September 1, no further growth in height, but spreading out, forming a compact sod.

*Phleum pratense.*—July 1, one-half inch high. July 15, 2 inches high. August 1, 4 inches high, looking fine. August 15, 6 inches high. September 1, 6 to 9 inches high, a few heads appearing.

*Avena elatior.*—July 1, 1½ inches high. July 15, 4 inches high. August 1, 8 inches high. August 15, 12 inches high. September 1, 12 to 18 inches high, a few heads.

*Festuca elatior.*—July 1, 1 inch high. July 15, 3 inches high. August 1, no growth. August 15, 4 inches high. September 1, no growth.

*Dactylis glomerata.*—July 1, 1 inch high, heavy stand. July 15, 3 inches high. August 15, 6 inches high. September 1, 12 inches high, spreading and forming a good sod.

### EXPERIMENTS WITH POTATOES.

A midsummer frost July 6, and another August 26, made it impossible to draw any conclusions from the potato experiments.

Early Rose and Early Burbank were planted May 10. They began to appear above ground by July 1. The frost of July 6 destroyed the tops, but they rallied and made a rapid growth until August 26, when the vines were again frozen to the ground without having come into bloom. No growth has taken place since.

Planted potato eyes of the following varieties: May 13, Hamilton Early, Extra Early Ohio, Extra Early Triumph, and Carman No. 3. Two rows of each variety were planted, and one row of each fertilized with kainit. These plants were killed by frost July 6, and never recovered.

Planted Bovee and Extra Early Ohio May 24. Two rows of each variety were planted, one row of each being fertilized with kainit. The Bovee never recovered from the frost of July 6. The Extra Early Ohio recovered and made a rank vine growth, but was killed by the frost of August 26 without having come into bloom. No noticeable difference between fertilized and unfertilized rows.

### LIVE STOCK.

The cattle now owned by the station are: Three work oxen, 4 milch cows, and 3 calves. They were fed exclusively on native feed during the winter, and came through in excellent condition. Two of the cows were in milk during the winter months, their record being given below.

The calves were removed from the cows shortly after birth and taught to drink milk. They were fed on whole milk until two weeks old, and then gradually brought to a skim-milk diet. They were weaned at four months. The calves remained vigorous and healthy at all times, and are in excellent condition at present.

As during other seasons the oxen were fed nothing but native feed while working, and remained in fair condition. The station has so much land cleared now that an ox team is too slow to do the work properly. It is hoped to have a team of horses next year.

### MILK RECORD.

In comparing these records with records made by cows in the States it must be borne in mind that the cows owned by this station have not been heretofore properly fed, bred, or milked to develop dairy characteristics. They are native cattle, closely inbred, accustomed to be milked while on grass in the summer and forced to shift for themselves for the larger part during the winter, under which conditions of course the milk flow ceases. Cows reared under such conditions will not give the best results even with the best of feed. Definite conclusions can be drawn from the results only when the station will be able to experiment with cattle of a distinct breed.

*Bourka.*—Dropped calf December 7, 1903. Milking period in days, 268; total yield, 5,437.5 pounds; average daily yield, 20.29 pounds. Besides being a persistent milker this cow gives milk that appears to be very rich in butter fat. She is the best cow in the herd.

*Snowball.*—Dropped calf January 10. Milking period in days, 230; total yield, 1,818 pounds; average daily yield, 7.81 pounds. This cow dropped her calf when but 18 months old. Her average daily yield for July was twice as great as that of January.

*Liska.*—Dropped calf April 10. Milking period in days, 143; total yield, 2,675.5 pounds; average daily yield, 18.64 pounds.

*Marka.*—Dropped calf May 7. Milking period in days, 115; total yield, 2,043.5 pounds; average daily yield, 17.76 pounds.

The record given for each of the cows ends September 1. All are still in milk.

Besides feeding the calves there was enough milk to supply the local demand.

The butter made was first-class in every respect. We have nothing but the crudest of utensils to use in butter making. One of the needs of the station is a complete dairy outfit.

Respectfully submitted.

P. H. Ross,
*Superintendent Kenai Experiment Station.*

Prof. C. C. Georgeson,
*Special Agent in Charge of Alaska Investigations.*

## COPPER CENTER STATION.

Work has been pushed successfully at this station throughout the open season. Sixteen acres were under culture the past season and 21 acres more have been cleared, making a total of 37 acres at this writing. Only 6 acres of the new clearing have been broken, however, but it is hoped to break 10 acres, or possibly more, in the spring before seeding. Mr. Neal has in addition built a cottage, which he now occupies with his family, and also a barn with shed attached, though the roof is not completed at this writing. A good team of horses has been purchased to replace the worn-out team of pack horses, and the stock of implements has been added to. There is still needed a blacksmithing outfit, a fanning mill, a hand seed drill, and some hand tools, which it is hoped to supply this winter.

Mr. Neal reports that he found it difficult to get good men to work, even at $5 a day, which has been the wages paid for white labor. The cost of living is $4 a day for board and lodging.

## TRAIL WORK.

Mr. Neal spent over three months on the trail—namely, from January 9 to April 19—hauling our equipments of feed, fertilizers, and seed grain, and a few implements from Valdez to Copper Center. This work is exceedingly hard on both man and beast, and nobody can stand it for many years in succession. Mr. Neal could not handle this freight alone, and still we had no money to hire help. The wages of a man on the trail is $125 a month, but the seed grain, fertilizers, and other things had to get in on the snow, so Mr. Neal exchanged labor with John McCrary, a settler in the Copper River Valley, who needed supplies hauled over, and an arrangement was made by which Mr. McCrary helped Mr. Neal on the trail every day during the three months, and as compensation we hauled in his provisions, weighing 1,433 pounds, the price for hauling being fixed at 15 cents a pound. This would not pay Mr. McCrary's wages for the whole period, so Mr. Neal arranged with the road-house keeper at Ernestine to haul in 1,600 pounds of provisions for him at 10 cents a pound, Ernestine being a little more than half way to Copper Center. By this means the station equipment was landed without having to pay out anything for labor.

As stated in the last report, half the equipment sent in a year ago was stranded at Teikhel, the snow leaving the ground when that place was reached. This equipment remained stored until last winter, when it was very kindly taken in by the military forces at Fort Liscum on the application of the Secretary of Agriculture. It was a small matter to the military department, as they had the men and an abundance of horses. We could not have taken it in with the funds at our disposal. We had more freight to transport from Valdez than could be handled by one man or one horse, and Mr. Neal could not handle two horses alone. By adding a ton and a half we had the services of a man to lead one horse and to help with the loading and unloading at relay stations and in the thousand emergencies where help is needed on the trail.

### EXPERIMENTS.

We had upward of 150 plats at the station, large and small, in which were tested many varieties of barley, oats, wheat, vegetables, and grasses. Tests were made with and without fertilizers and on newly cleared ground compared with ground cultivated last year (Pl. IX, fig. 1). It was again confirmed, as in former years, that new land is less productive than land which has been under culture. The experiments also prove that the soil responds to fertilizers. The details of these tests are given in Mr. Neal's report, submitted herewith.

The bulk of the grain failed to mature. Sixty-day oats and Finnish Black oats matured in part, and also a little each of Manchuria, Lapland, and Manshury barley, but none of the wheats matured. A killing frost occurred August 17, and this, of course, destroyed much of the experimental value of our work. The frosted grain has been cut for hay, and the relative yield of hay of each variety of grain, on fertilized and unfertilized plats, is given in Mr. Neal's report. Although the bulk of the grain was killed, the results were better in the interior than on the coast. In the interior we matured some grain, while in the coast region none whatever matured, and in many places the grain was scarcely formed in the heads.

It is our plan to continue to clear land at the Copper Center Station to the extent our funds will permit, until we shall have well on toward a hundred acres in cultivation. The coming year it is also planned to seed down large plats to those grasses which give promise of doing well there in order to afford pasture for the stock. It is also time to introduce a few cows at the station, so that we can note how they thrive under the conditions there presented.

In former reports it has been explained that the land in the Copper River Valley lies in broad terraces or benches. Our clearing, so far, has been on the second bench, counting the river bottom the first bench. Mr. Neal observed that the vegetation seemed to suffer less from frost on the upper benches than on the bench where the clearing is located, and we will therefore clear some land on each bench in order to see if the higher ground is more immune from early frosts, as seems quite possible.

### REPORT OF J. W. NEAL, SUPERINTENDENT OF COPPER CENTER STATION.

Copper Center, Alaska,
*October 5, 1904.*

Dear Sir: I herewith submit my third annual report from the Copper Center Experiment Station, disclosing the season's work for 1904.

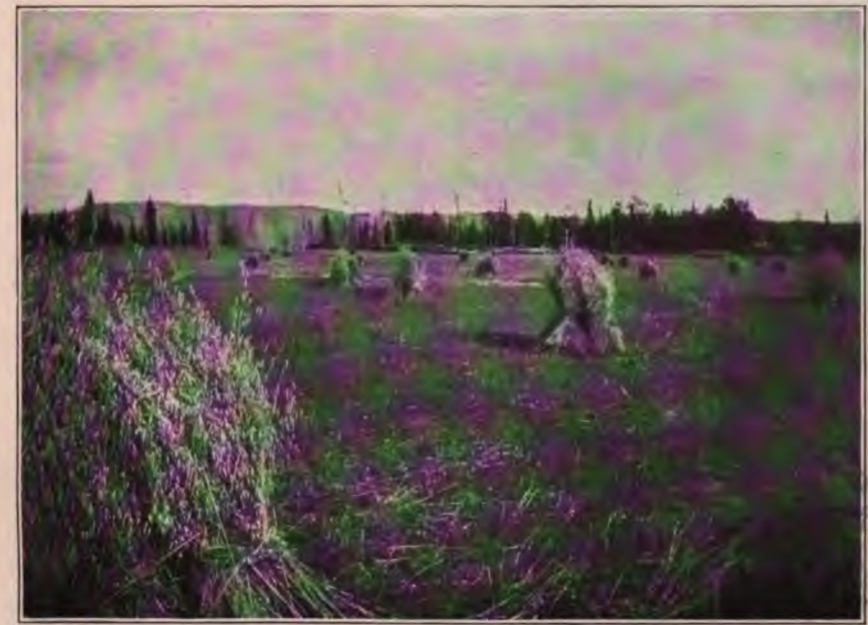

FIG. 1.—RIPE SIXTY-DAY OATS HARVESTED FOR SEED AT COPPER CENTER STATION, 1904.

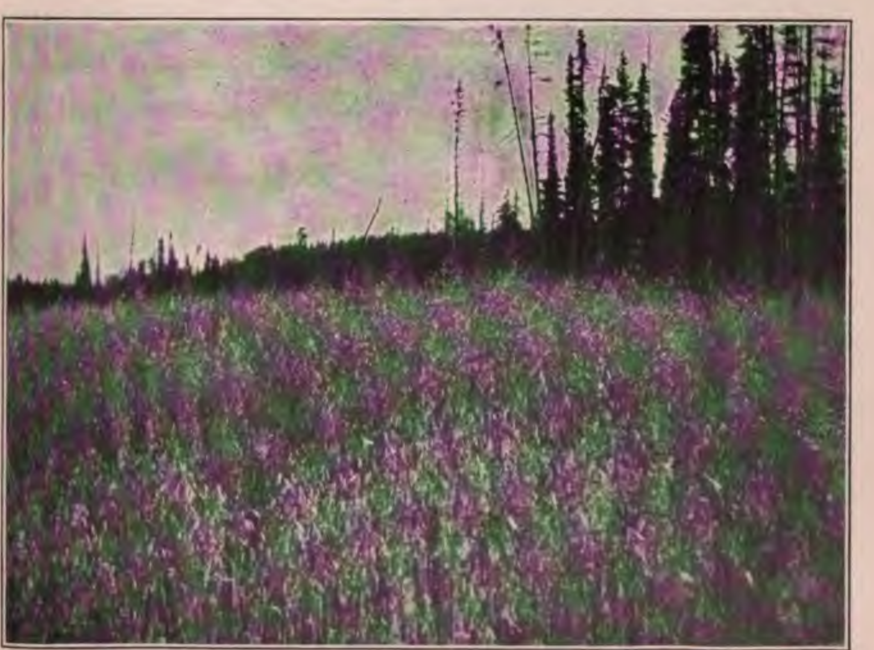

FIG. 2.—HEAVY GROWTH OF FINNISH BLACK OATS, 1904, AT COPPER CENTER.

After closing my last report I learned that our funds were too limited to attempt to finish the station cottage for winter quarters, and at your suggestion I secured a cabin at Copper Center from Mr. Blix, which with a little renovating made quite comfortable winter quarters for myself and family.

During the early winter I spent my time getting out timbers for a barn and cache. And by exchanging some work with a neighbor, I got the cache up and barn well started.

As it was now nearing the winter freighting season, and our team being again wintered in Valdez, I left Copper Center on January 9, traveling by dog team. I arrived at Valdez on the 17th, being out nine days in deep snow and bitter cold. I found our supplies about all packed ready for transportation. It required some three days, however, to fit up sleds and accustom the team to the snow trail. Finding I could not handle the stuff alone, and there being no available funds with which to hire help, by authority, I made an agreement with John McCrary to drive one horse for us at $125 per month, boarding himself, he to be remunerated in freight hauled with the station team at 10 cents a pound to Ernestine, and 15 cents a pound to Copper Center. This arrangement resulted in McCrary working three months ($375), we hauling for him to Ernestine 1,600 pounds ($160) and to Copper Center 1,433 pounds ($214.95), making a total of $374.95 for his services.

We hauled our first load out of Valdez January 21, landing everything at the station April 19, the snow then being gone from all exposed places. We experienced two severe storms in the vicinity of Thomsons Pass, and our stock suffered some injury. The ground being yet frozen, I cut and hauled some saw logs and worked on the cottage until April 28. The frost was then sufficiently out of the ground, and I began plowing April 30. I seeded some 3 acres to wheat, barley, and oats. Plowing and seeding continued until May 14, when our horse feed gave out, and I turned the team outside. We then had about 14 acres seeded and 2 acres of sod broken. Hand seeding continued until May 20.

We cleared for the season about 21 acres, 6 of which have been broken. The early frost has hindered the fall breaking.

### IMPROVEMENTS.

Since the last report we have built a 12 by 16 foot cache and seed room, made the cottage habitable for winter quarters, and added a 12-foot shed roof for summer kitchen; also a log barn 20 by 24 feet, 13 feet high, with a 14-foot shed on two sides. The sheds are covered with bark and the main part as yet with canvas, for want of roof material.

### HELP AT THE STATION.

For the last twelve months we have had no regular help, but simply hired men when we needed them most, paying white men $5 per day and the natives $3 per day, as my instructions were to pay no more. Owing to the high prices here and board at the road house being $3 per day or $4 with lodging, I found it difficult to get good men at these wages for the short time we hire them. My wife offered to board the men at $2 a day, not charging them for Sundays and rainy days. This enabled me to get good men at the set wages. She boarded the native help at $1 per day, working days only, which was less than actual cost of the food consumed.

### WEATHER CONDITIONS.

Unlike last year, the spring opened early and at first promised a favorable season. The seeds germinated quickly and grew very rapidly for a time. In fact, the growth was rapid throughout the season, but there being little sunshine and much damp weather, the crops had little tendency to mature. The temperature fell to the frost line every month in the season. During May we had rain thirteen days and not a single clear day. In June we had rain twenty-four days and not a single clear day. In July we had rain twenty-three days and five clear days. In August we had rain nineteen days and six clear days, with seven days frost, the lowest 24° F. In September we had rain twelve days and sixteen clear days, with nineteen days frost, the lowest 6° F.

As a result of these weather conditions, the grain was slow to head and very slow in filling. The straw remained green in many instances all fall and froze while yet green. Wheat and barley were frosted, but several varieties of oats ripened as good seed apparently as last year.

### FIELD NOTES.

*Barley.*—Manshury, seeded April 30 on old and new ground, coming up in fifteen days; stand thin. This was home-grown seed, flailed out and poorly cleaned, which caused thin seeding. June 1, 3 inches high and looking good. June 15, 5 to 7 inches high and stooling well. July 1, the best 12 inches high. July 15, 24 to 30 inches high and heading. August 1, 42 inches high, in full head, and grain half formed. August 15, straw turning fast and grain in the dough. Some ash spots more advanced. August 17, the temperature fell to 26° F., frosting nearly all of the barley. For some time thereafter the weather kept damp and cloudy, keeping the straw green. A few high spots matured good heads. The crop was cut for hay September 2, saving the few matured head for seed. The old ground produced fully 90 per cent more feed stuff than the new.

A 2-acre plat, new ground of fall breaking, was seeded with imported seed May 14. This came up in nine days. Stand good. June 1, 2 to 3 inches high. Good color. Ash spots very marked. June 15, 4 to 8 inches high, rank growth, and stooling well on the ash spots. July 1, 12 inches high on the ash spots and little growth elsewhere. July 15, best 30 inches high and just beginning to head. August 1, on the ash spots in full head, 4 feet tall, and very thick on the ground. The grain about one-third formed. Other portions headed 12 to 20 inches high. August 15, passing into the dough and straw ripening fast on the ash spots. This, too, was frosted August 17, and cut for hay on August 24.

Still a third plat was hand drilled May 17 from home-grown seed, half of this plat being fertilized with fish guano at the rate of 500 pounds per acre, drilled with the grain in one application. This seeding came up in ten days. Stand a little thin. June 1, 2 inches high. Color good. June 15, 6 inches high and stooling. The fertilized portion now showed a ranker growth. July 1, best 12 inches high; the unfertilized 8 inches high. July 15, 24 inches high and signs of heading; unfertilized portion 12 to 16 inches high. August 1, 52 inches tall. Thick and even on the ground. The grain about one-third formed. The unfertilized portion stood 36 to 40 inches tall and much thinner, as it stooled very little. The heads were much younger. August 15, straw turning, grain about full size. Unfertilized portion more backward. August 17, the grain was frosted and later the whole crop turned into hay.

Lapland, seeded April 30 on old and new ground, coming up in fourteen days. Stand good. This was home-grown seed, flailed out, but comparatively easily cleaned. June 1, 1 to 3 inches high and looking good. June 15, 4 to 8 inches high, the best being on the old ground. It was stooling some and looking good. July 1, 12 to 18 inches high and signs of heading. July 15, 24 to 30 inches high and heads just out. August 1, 36 to 40 inches tall, headed out, and grain one-third formed. August 15, straw quite yellow and grain in the dough. The furthest advanced of all varieties. August 17, the grain was injured by frost. Some heads were past danger. The crop was cradled, bound, and stored, to be tested for seed.

A plat was drilled May 17 from home-grown seed, one-half of the plat being fertilized with fish guano as the above. This was coming up in 10 days. Stand fair. June 1, 2 inches high. June 15, 6 inches high, thrifty and good color; the unfertilized had made 4 inches growth and had a pale color. July 1, 7 to 13 inches high. July 15, the best 30 inches high and heading; unfertilized, 12 inches

*Wheat.*—Roumanian spring, seeded April 30 on old and new ground, coming up in thirteen days; stand good. July 1, 4½ inches high, looking good. June 15, 6 to 10 inches high, and stooling some on the old ground. July 1, average 12 inches high. July 15, 18 inches high, heading. August 1, best 30 inches high, a little thinner on the ground; heads small, beginning to fill. August 15, straw turning, heads well filled. Grain frosted August 17. Cut for hay September 1. The old ground produced about 40 per cent more feed stuff than the new.

Another plat was seeded May 5, in hand drills, and half the plat fertilized with fish guano at the rate of 500 pounds per acre, being drilled in with the seed in one application; coming up in eleven days, stand good. June 1, 3 to 4 inches high. June 15, 9 inches high, stooling well and looking fine where fertilized; unfertilized 6 inches high and stooling very little. July 1, best 15 inches high; unfertilized, 8 inches high. July 15, 24 inches high on fertilized portion, and just begun heading; unfertilized 12 inches high, not heading. August 1, average 42 inches high, and quite thick growth on fertilized ground; just beginning to fill; unfertilized 30 inches high, thin on the ground, grain a little more advanced. August 15, straw turning, grain two-thirds filled, heads large. Grain frosted August 17. Straw quite green and sappy yet. September 1, crop cut for hay.

Another plat was seeded May 7 on old ground with seed drill, coming up in eleven days; stand very good. June 1, 3 inches high. June 15, 7 to 8 inches high and stooling some, looking fine. July 1, best 13 inches high. July 15, 18 to 20 inches high, about heading. August 1, in full head 24 to 40 inches high, grain just beginning to fill. August 15, straw turning, grain three-fourths filled. Grain frosted August 17. Straw quite green when cut September 1 for hay. This plat produced a good average crop of hay.

Dufferin spring wheat, seeded May 4, in hand drills and half the plat fertilized with fish guano at the rate of 500 pounds per acre in one application, coming up in eleven days; stand good. June 1, 4 to 5 inches high. June 15, 11 inches high and stooling well where guano was used; unfertilized, 8 inches high, stooling very little. July 1, best 22 inches high; unfertilized, 17 inches high. July 15, 30 to 36 inches high where fertilizer was used; unfertilized, 18 to 22 inches high; both heading. August 1, 48 inches tall, in full head and grain filling on fertilized portion; unfertilized, 36 to 42 inches tall, grain about the same. August 15, straw turning, grain three-fourths filled. Grain frosted August 17. Straw quite green yet, September 1, when cut for hay. This plat produced a very heavy crop of straw.

and the grain in the stiff dough; other portions quite green and short. August 17, grain frosted and shrunk badly. Cut for hay September 1.

Another plat was seeded May 14 on new ground, coming up in ten days; stand good. June 1, 2 to 3 inches high; color good. June 15, 6 to 7 inches high on ash spots, and stooling; other portions 4 inches high. July 1, 12 inches high on ash spots; other portions making little growth. July 15, best 20 inches high and thick on the ground; signs of heading. August 1, heads well out some days, standing 40 inches high. August 15, straw turning and grain in the dough. August 17, grain frosted and cut for hay a few days later. The ash spots yielded a heavy crop, but the other portions not worth cutting.

Still another plat was seeded May 17 in hand drills, one-half being fertilized with fish guano as above varieties, coming up in eleven days; stand medium. June 1, 1 inch high. June 15, 6 inches high and stooling well on the fertilized portion; about half as much growth on unfertilized portions. July 1, best 9 inches high. July 15, best 22 inches high and signs of heading. August 1, 36 to 40 inches tall and headed; unfertilized, 24 inches tall and just heading. August 15, straw turning and grain in the dough; unfertilized portions more backward. August 17, grain frosted and the crop cut for hay.

Royal, seeded May 17 in hand drills, one-half being fertilized with fish guano as above varieties, coming up in ten days; stand good. June 1, 1 inch high. June 15, 6 inches high and stooling well on fertilized portions, other portions making less growth. July 1, best 12 inches high. July 15, 24 inches high and heading on fertilized portions; unfertilized, 14 inches high. August 1, best 40 inches tall, in full head, and grain about one-third formed; unfertilized portions 30 inches tall, heads younger, and grain much thinner on the ground. August 15, straw quite yellow and grain in the dough; unfertilized several days later. August 17, grain frosted and cut for hay later.

A Norway variety, offered by Burke, editor of Valdez Prospector, seeded May 14 in hand drills, one-half being fertilized with fish guano as above varieties, coming up in ten days; stand good. June 1, 1 inch high. June 15, 6 inches high and stooling well; unfertilized portions not quite so good. July 1, best 12 inches high; unfertilized 8 inches high. July 15, best 24 inches high and signs of heading; unfertilized 15 inches high. August 1, 46 inches high on fertilized portion, in full head, and grain forming; unfertilized, 30 inches tall and much thinner. August 15, straw turning. Grain of both plats in the dough. August 17, grain frosted and crop cut for hay.

Black Hulless, seeded May 17 in hand drills, one-half being fertilized with fish guano as above varieties, coming up in twelve days;

grain just beginning to fill; unfertilized a little thinner and some shorter straw, but less difference than on any other plat tested with the fertilizer. August 15, straw turning, grain two-thirds filled, heads large. Grain frosted August 17. Straw yet green September 1. This made a very heavy crop of straw; cut for hay September 1.

Russian (Orenburg) spring wheat, seeded May 15, and fertilized as above plats, coming up in eleven days; stand good. June 1, 3 to 5 inches high, looking much better where fertilized. June 15, 7 to 9 inches high, stooling well and looking fine where guano was used; unfertilized, 5 to 7 inches high and stooling very little. July 1, best, 16 inches high; unfertilized, 8 inches high. July 15, 22 inches high, about heading; unfertilized, 12 to 14 inches high. August 1, best, 40 inches high and thick on the ground; unfertilized, 24 inches high, quite thin on the ground, grain just beginning to fill. August 15, straw turning, grain two-thirds filled. Grain frosted August 17. September 1, straw yet green. Heavy crop of straw cut for hay.

Romanow, first importation, seed from Sitka, crop 1900, seeded May 5 in hand drills, a very small portion being fertilized with guano and a small portion with ashes. The ashes made no visible difference in the growth or advancement; probably not enough was used; coming up in eleven days. June 1, 3 to 4 inches high, all looking good, seeded very thin, seemingly every grain came. June 15, 6 to 7 inches high, stooling some and looking well; where guano was used, 7 to 8 inches high, stooling well. July 1, 10 inches high on the unfertilized, 14 inches high where guano was used. July 15, 15 inches high where no fertilizer was used, 24 inches high where guano was used; both about heading. August 1, 24 inches tall without fertilizer, 38 to 40 inches tall where guano was used; both full headed and grain just beginning to fill. August 15, straw beginning to turn, grain about two-thirds filled. Grain frosted August 17. No visible difference in the degree of ripeness; heads were much larger and grain well stooled where guano was used. The straw was cut for hay September 1, yet quite full of sap.

Another plat was seeded in hand drills May 14 where brush had been burned the year previous. As requested, I gave the variety special attention. This came up in ten days. June 1, 3 inches high, looking good. June 15, 6 to 9 inches high and stooling well. This was also seeded very thin, but stooled out to be quite thick on the ground. July 1, 12 to 14 inches high, looking fine. July 15, 18 inches high, about ready to head. August 1, 36 inches high, well headed out; some smut appeared. August 15, straw turning fast, heads large and well filled, grain about in the dough. Grain frosted August 17. Straw did not seem to ripen much after this frost. The crop cut for hay later. This variety was the farthest advanced of all the spring wheats when the killing frost came.

Pererodka spring wheat, seeded May 5 and fertilized as above plats, coming up in eleven days; stand good. June 1, 4 to 5 inches high. June 15, 7 to 9 inches high, stooling well and looking fine where fertilized; unfertilized, 6 to 7 inches high and looking fairly well. July 1, best, 15 inches high; unfertilized, 12 inches high. July 15, best, 28 inches high, about heading; unfertilized, 20 inches high, heading. August 1, 42 inches tall and thick on the fertilized ground, grain just beginning to fill; unfertilized, 36 inches high, some thinner on the ground, grain slightly advanced. August 15, straw turning, grain about two-thirds filled; unfertilized, a little advanced. Grain frosted August 17, heads large. September 1, straw yet quite green. The plat made a heavy crop of straw.

Kubanka spring wheat, seeded May 6, and half the plat fertilized as above variety, coming up in twelve days; stand good. June 1, 4 to 5 inches high; a little better where guano was used. June 15, 7 to 9 inches high, stooling well and looking fine where fertilized; other portions 5 to 7 inches high, stooling very little. July 1, best 14 inches high; unfertilized, 10 to 11 inches high. July 15, best 28 inches high, heading; unfertilized, 18 inches high, just beginning to head. August 1, 46 inches high and thick and even where fertilized, grain begining to fill; unfertilized, 38 inches tall, thinner on the ground, grain about the same. August 15, straw turning, grain about two-thirds filled; unfertilized, a little advanced. Grain frosted, August 17. September 1, straw sufficiently matured to make good hay.

Russian spring wheat, No. 2955, seeded May 6, and half the plat fertilized as above varieties, coming up in twelve days; stand very thin, seed evidently poor. June 1, 3 to 4 inches high, looking good. June 15, 5 to 8 inches high; no apparent difference from unfertilized. July 1, 12 inches high where fertilizer was used; unfertilized, 8 inches growth. July 15, best 20 inches high, signs of heading; unfertilized, 16 inches high. August 1, best 36 inches high, quite thick on the ground, heading; unfertilized, 26 inches high, some thinner, heading. August 15, grain half filled, straw quite green, some heads blighted. Grain frosted August 17. September 1, straw yet green, cut for hay.

Karkhov winter, seeded with seed drill August 11, 1903, coming up in ten days. Stand good, but the growth was not sufficient by winter to stand the extreme cold. Fully 90 per cent was winter-killed. What lived through was very weak and showed no signs of growth until May 5. The snow was off the plat April 20. June 1, 4 inches high, stooling some, and looking good in spots. June 15, 8 to 10 inches growth, jointing. July 1, 12 to 15 inches high, sign of heading. July 15, 18 to 20 inches high and heading. August 1, blooming. August 15, grain nearly filled, some heads well filled, straw yet very green. Grain frosted August 17. Straw had not fully matured when cold weather came. This grain was seeded too late. This season our winter wheat was seeded about thirty days earlier, and as the season closes the ground is a carpet of green.

*Rye.*—Excelsior, seeded August 11, 1903, in hand drills, coming up in ten days; stand poor. Only a small percentage stood the winter and started very slow in spring. June 1, stooled some and jointing, 10 inches high. June 15, 18 inches high and heading. July 1, 36 inches high, headed. July 15, 40 inches high, passing from the bloom. August 1, grain half formed, some heads blighted. August 15, the few good heads left nearly filled. Grain frosted August 17. The straw did not mature fully.

Russian winter, No. 2961, seeded as above August 11, coming up in ten days; very little stood the winter. The little that lived through came very slowly in the spring. June 1, 6 to 8 inches high, stooled some, and jointing. June 15, 16 inches high. July 1, 24 to 30 inches high, heading. July 15, 30 to 40 inches high, not bloomed yet. August 1, just beginning to fill. August 15, grain nearly filled, some heads blighted. Grain frosted August 17. Straw still green and did not fully mature.

Winter, No. 5903, seeded August 11, coming up in ten days, stand poor and much of it winterkilled. June 1, 8 inches high, stooled some, and jointing. June 15, 16 inches high. July 1, 24 to 36 inches high, heading. July 15, 40 to 48 inches tall, not bloomed. August 1, beginning to fill. August 15, grain about half filled, some heads blighted. Grain frosted August 17. Straw did not fully mature until cold weather.

Schlansted winter, seeded August 11, coming up in ten days. Only a small percentage came, and all was winterkilled.

Like the winter wheat, I am convinced that the rye was seeded too late to get well enough started to stand the cold winter. The winter rye this season was seeded a month earlier than last year. At the close of this season it shows a rich carpet of green.

Russian Spelt No. 2789, seeded May 6 in hand drills, and half the plat fertilized with the guano at the rate of 500 pounds per acre, coming up in twelve days. Only a few seeds came. June 1, 4 to 5 inches high. June 15, 7 to 8 inches high; no apparent difference from unfertilized. July 1, 12 inches high; slightly better where fertilized. July 15, 15 inches high. August 1, 28 inches high; heading. August 15, 36 inches high; grain just beginning to form. Grain frosted August 17, straw did not mature. Cut green about September 15 for hay, and cured with difficulty.

Yaraslof spring Emmer, seeded May 6 and fertilized as other plats, coming up in twelve days; stand good. June 1, 3 to 5 inches high; doing much better where fertilized. June 15, 7 to 9 inches high, stooling well, and looking fine where fertilized; 5 to 7 inches high on other portions. July 1, best 12 to 14 inches high; unfertilized, 9 to 10 inches high. July 15, best 20 to 22 inches high, an occasional head appearing; unfertilized, 12 to 14 inches high. August 1, 42 inches high, thick and even on fertilized ground, headed, but young; unfertilized, 22 inches high, much thinner on the ground, headed about the same. August 15, straw beginning to turn, grain about half filled. Grain frosted August 17. Straw kept green all fall. Cut green for hay.

Uba spring Emmer, seeded May 6, and half the plat fertilized as the other varieties, coming up in twelve days; stand good. June 1, 3 to 5 inches high, all looking good; some better where fertilized. June 15, 8 to 9 inches high, well stooled, and looking fine where guano was used; unfertilized, 6 to 8 inches high, looking well. July 1, best 13 inches high; unfertilized, 9 to 11 inches high. July 15, 18 to 20 inches high on the fertilized ground, no signs of heading; other portions 14 to 18 inches high. August 1, best 36 inches high, very thick and even over the ground, heads just out; unfertilized, 28 to 32 inches high, not so thick on the ground, heads out the same. August 15, grain two-thirds filled. Grain frosted August 17. Straw kept green all fall. Cured for hay with some difficulty.

*Buckwheat.*—Silver Hull, seeded May 18, in hand drills and half the plat fertilized with guano as other plats, coming up in fourteen days; stand fair. June 1, coming up. June 15, 2 inches high, third leaf set. July 1, 4 to 5 inches high; much ranker where guano was used. July 15, 10 to 12 inches high, bloom setting. August 1, 30 inches high, well stooled, and covered with blossoms; unfertilized, about half as good. August 15, frost, somewhat injured. Frost August 17, killed all the buckwheat.

Finnish, a few plants came volunteer where it was grown last season. These scattering plants made a good growth and bloomed by July 1. The August frosts killed every plant.

### GRAIN HAY.

The following table gives the amount of hay grown per acre, this season on second-year ground, with and without fertilizing. The plats tested were 30 feet square to each variety. One-half of each plat was fertilized with fish guano at the rate of 500 pounds per acre. The crop, when cured sufficiently for storing, was carefully weighed and figured, deducting 25 per cent to make sure of final shrinkage. The tract where these experiments were carried on is light soil, and proved to be very poor. Unfertilized ground the same age in other parts of the station produced equally as much as many of these fertilized plats.

*Yield of grain hay on second-year ground with and without fertilizers.*

| Variety. | Unfertilized. | Fertilized. |
|---|---|---|
| | *Pounds.* | *Pounds.* |
| Romanow spring wheat | 1,186 | 4,237 |
| Pererodka spring wheat | 1,356 | 2,966 |
| Russian (Orenburg) spring wheat | 847 | 2,373 |
| Kubanka spring wheat | 1,186 | 4,068 |
| Dufferin spring wheat | 1,271 | 5,085 |
| Ladoga spring wheat | 1,779 | 3,813 |
| Harold spring wheat | 847 | 2,343 |
| Plumper spring wheat | 1,059 | 3,135 |
| Glyndon spring wheat | 1,356 | 4,915 |
| Romanow spring wheat | 1,610 | 2,373 |
| Lapland barley | 1,101 | 2,966 |
| Manchuria barley | 1,525 | 3,305 |
| Manshury barley | 1,271 | 4,746 |
| Finnish barley No. 6175 | 1,271 | 3,973 |
| Burt Extra Early oats | 932 | 3,262 |
| Sixty-day oats | 1,831 | 3,204 |
| Duppaur oats | 1,907 | 3,814 |
| Finnish Black oats | 1,525 | 4,237 |
| No. 2800 oats | 763 | 3,357 |
| Excelsior winter rye | 847 | 3,390 |
| Uba spring Emmer | 1,221 | 3,678 |
| Yaraslof spring Emmer | 1,101 | 4,152 |

## GRASSES AND FORAGE CROPS.

Timothy of the 1903 seeding had made a good heavy sod. June 1, it made good pasture. July 1, heading. When matured it stood 3 feet high and reminded us of an eastern meadow. The crop was light. Seed matured.

The same, seeded May 6, 1904, and half the plat fertilized with guano at the rate of 500 pounds per acre, coming up in ten days. June 1, drills showing a little green. June 15, 1½ inches growth and set thick. July 1, 5 inches growth. July 15, 7 inches growth. August 1, heading. September 1, stems 24 inches high. Unfertilized portion about half the growth.

Redtop of 1903 seeding did well this year. June 1, afforded some grazing. July 1, 18 inches high, heading. Seed about mature August 15. The full growth was 24 inches and quite thick.

Brome grass of 1903 seeding was well set and made excellent pasture by the middle of May. June 1, 6 inches growth. June 15, 12 to 18 inches growth. July 1, best 30 inches high, thick on the ground. August 1, undergrowth thick, 20 inches high; heads 36 to 40 inches high.

Same, seeded May 6, 1904. Half the plat fertilized as the timothy, coming up in twelve days. June 1, 1 inch growth. June 15, 3 to 4 inches growth, set thick. July 1, 6 to 7 inches growth. August 1, heading, looking fine. September 1, 18 inches high where fertilized; 12 inches high elsewhere.

Bluegrass, 1903 seeding. June 1, showing quite green, a little thin. June 15, 5 to 7 inches growth, much thicker. July 1, stems

18 inches high, heading. July 15, 24 inches high. August 15, seed about mature.

Orchard grass, 1903 seeding. June 1, showed quite green. June 15, 3 to 5 inches growth. August 15, ground well covered. A good sod.

Same, seeded May 6, 1904. Half the plat fertilized with guano, coming up in eleven days. June 1, drills showed a little green. June 15, 2 inches growth, set thick. July 1, 5 inches growth. July 15, 8 inches growth. August 1, looking fine. September 1, 10 to 12 inches high where guano was used; elsewhere about half the growth.

Meadow foxtail, 1903 seeding. June 1, showed quite green. June 15, 5 to 7 inches high, some stems thrown out, and heading. July 1, 20 inches high, headed. July 15, 30 inches high. August 15, seed quite mature.

Meadow fescue, 1903 seeding. June 1, 3 inches growth. June 15, 8 to 12 inches growth. July 1, best 40 inches high, heading. July 15, 30 to 40 inches high. August 1, in bloom, best 48 inches tall. No seed matured.

Same, seeded May 6, 1904. Half the plat fertilized with fish guano as other varieties. June 1, not up. June 15, 2 inches growth. July 1, 4 inches growth. July 15, 5 inches growth. September 1. a good sod and well stooled. A few stems thrown out. No noticeable difference from unfertilized.

Red clover, 1903 seeding. A few stalks lived through the winter. June 15, 2 to 3 inches growth, with a number of leaves and several stems. July 1, looking good. July 15, 6 inches high. August 1, a few plants in bloom. Several plants blossomed late in August. August frosts injured the plants badly.

Same, seeded May 19, 1904. Half the plat fertilized with guano. Coming up in twelve days. June 15, 3 leaves set. July 1, looking fair. September 1, 4 to 6 inches high and quite spread out, but very small for a season's growth. The growth was much better where guano was used.

Aslike clover, 1903 seeding. June 15, a few plants appeared small, but several leaves. July 15, some plants 4 to 5 inches high. August 15, little more growth. Did poorly for the season.

Same, seeded May 19, 1904, coming up in fourteen days. June 15, 3 leaves set. July 1, making slow growth. July 15, little growth. Unfertilized plants did the best, but neither made much showing.

White clover, seeded May 19, 1904, coming up in twelve days. June 15, 3 leaves set. July 15, showing quite green. September 1, a good stand, but plants very small. The season was evidently too cold for all the clovers.

### THE GARDEN.

The season this year proved very unfavorable for many hardy vegetables which were noted as a success last year. The precipitation for the growing season was about 6 inches, but the weather kept cool and cloudy so much that the garden stuff came on very slowly. The temperature reached 87° F. only once during the entire season. During the month of June the warmest day was 76° F.

Cabbage and cauliflower were started in boxes indoors in March. Good plants set in the open ground June 1. These made good-sized plants by fall and some heads forming, but not to say fit for table use, except as greens. The cauliflower formed tiny heads the size of walnuts.

Turnips, radishes, parsnips, carrots, lettuce, spinach, cress, mustard, and kale all did about the same as last year. Peas were almost a total failure. Onions from seed made very small bulbs.

Early curled parsley, seeded May 16. Only 4 plants came up. These made nice plants.

Ruta-bagas, started in a warm frame early in May and transplanted to the garden in June, made a rapid growth. These were set 12 inches apart each way. Late in July the tops covered the ground. September 15, some were pulled, the tops being over 2 feet long. The roots measured 16 inches around, weighing 3 pounds. Those seeded in the open ground fell considerably short of this, yet they made a fair size for table use.

Beets, Golden Tankard, made roots 7 to 10 inches around. Crimson Globe, 6 to 9 inches around.

Rhubarb from seed last year made good-sized stalks this year, and indicates that it is well adapted to this section.

Broad Windsor beans, nine varieties were received and planted with care, after danger of spring frosts. Nearly every seed came. Each variety made good plants, blooming about July 15, pods setting August 15. Frost August 5 injured some. A heavy frost August 17 killed what had escaped.

Potatoes, Extra Early Triumph, Extra Early Ohio, Hamilton Early, and Carman No. 3 were received through the mail in fair condition. The seed was divided, half being planted immediately, the remainder being kept in warm moist soil about a hot frame for some days before planting. The latter came up first and as a result made a little better crop. Giving these varieties special attention, I covered them with canvas when there was any danger of frost. The eyes planted were very small and naturally the tops did not get very large. All made a fair growth, however, and looked healthy. No variety blossomed. The tops froze late in August under canvas. September 12 the crop was dug and put away for seed. Although immature the tubers were from the size of marbles to guinea eggs.

I had 25 pounds of Burbank potatoes shipped in from Valdez on the late snow, costing $11 at the station. The smaller ones were planted whole and the large ones cut in half. These were planted May 16. The first hill appeared June 1. All up June 15 and growing nicely. July 15, tops rank and large. Some in bloom. These potatoes were planted close to the edge of a bluff and escaped the early frosts. The later frosts froze the vines. The yield was small, yet four hills made two good, hearty messes for six people. The potatoes were small, but quite large enough for table use.

### THE FLOWER GARDEN.

The flower garden, although much neglected, was a pleasure and a scene of beauty.

Pansies did well, blooming from August 17 until winter set in.

Nemophila, mixed, made a profusion of flowers through August and September; excellent for borders.

Poppies, both the California and mixed, gave a profusion of flowers for a long period.

Larkspur did well.

Candytuft, white and purple, was very showy through August and September.

Phlox blossomed in September, a bright red.

Collinsia did well.

Mignonette blossomed in August.

Crimson flax blossomed in August.

### RECOMMENDATIONS.

I recommend as especially needed at this station a seed drill with fertilizer attachment, 1 fanning mill, 1 complete blacksmithing outfit, 1 grain cradle with extra blade, and 1 16-inch breaking plow with extra share, the John Deere brush breaker preferred, with standing cutter and gauge wheel.

The question of forage has been one of the perplexing problems at this station, but I now feel safe in recommending the starting of a small dairy herd. Reverend Clevenger, the missionary, wintered a milch cow at Copper Center last winter on native hay with very little grain. The cow gave a good flow of milk all winter and raised a fine heifer calf. We paid Mr. Clevenger $10 a month all winter and to September 1 for 1 quart of milk a day. Mr. Blix paid him $20 a month for 2 quarts a day during this time. Mr. Clevenger said they had plenty of milk for their own use and made their own butter.

Respectfully submitted.

J. W. Neal,

*Superintendent Copper Center Experiment Station.*

Prof. C. C. Georgeson,

*Special Agent in Charge of Alaska Investigations.*

## RAMPART STATION.

The reservation at Rampart was made in 1900, and Mr. Isaac Jones was left in charge. He resigned in the fall of 1901. Since that time no improvements have been made at the station except to cultivate the patch of ground cleared by Mr. Jones. The work at the other stations had now progressed so far that it was deemed wise to spend less elsewhere and more at Rampart. With a view of developing this station to the extent our funds will permit, an equipment has been purchased and sent up, and Mr. Fred E. Rader was detached from the Sitka Station, where he had been assistant since the spring of 1900, and placed in charge of the Rampart Station.

Mr. Rader left Sitka July 7 for his new field of work and arrived at Rampart July 29. When he reached Dawson he found that no boat would go down the river for a number of days, and so rather than waste his time waiting he and two or three other persons bound down the river purchased a small scow, in which they drifted down.

Mr. Rader's report has not come to hand at this writing, but I gather the following data from his letters: The grain which was seeded by Mr. J. W. Duncan on the half acre of cleared land was very promising. The barley matured fully and was cut August 16. The ground from which it was cut was spaded up at once and seeded to several varieties of winter wheat and rye. The oats also matured a little later, but the wheat was caught by frost during the first days of September, before it was ripe, though he thinks some of it may grow.

Here, then, we have the somewhat remarkable phenomenon that barley and oats have matured this season in latitude 65° 30′ N., while at the Copper Center Station, in latitude 62° N., these same varieties were killed. The oats saved—the Sixty-day, and it was partly injured—is earlier than any variety grown at Rampart. In the coast region to the southernmost limit of Alaska, in latitude 55° N., no grain matured. It would be erroneous to infer that grain will do better in latitude 65° N. than in regions farther south; but it must nevertheless be noted that grain has matured at the Rampart Station every year from 1901 to 1904, both inclusive. (Pl. XI, fig. 1.)

Mr. Rader hired a couple of men at $6 a day each and began clearing at once. By September 1 he had cleared 2½ acres of new ground. He also built an addition 12 by 14 feet to an old cabin on the reservation, and he and his wife will live there until a better house can be provided. The implements purchased for the station left Seattle about July 15 and arrived safely at Rampart early in September, and seed grain for spring use, shipped from Sitka in July, had also arrived. We have as yet no horses or live stock of any kind at this station, but

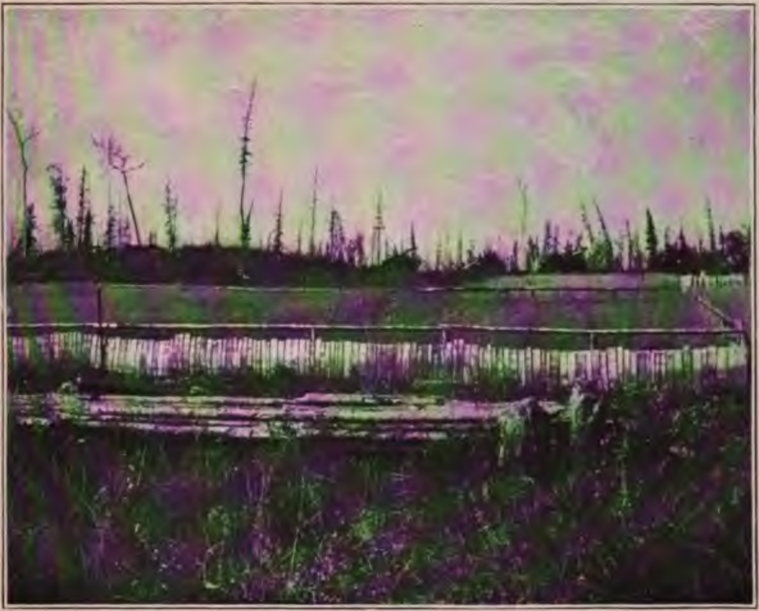

FIG. 1.—FENCE BUILT AT RAMPART TO KEEP THE RABBITS FROM THE GRAIN.

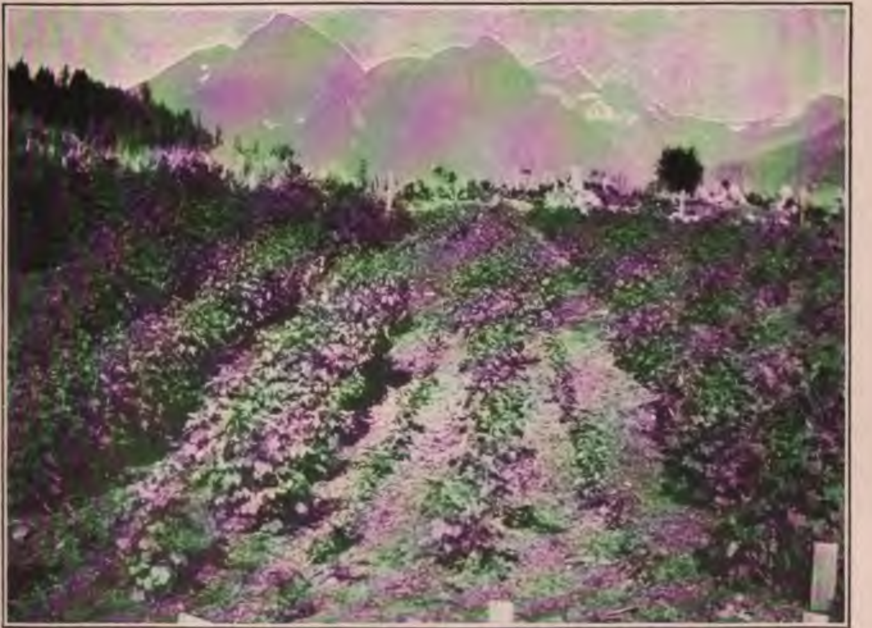

FIG. 2.—VIEW OF PORTION OF THE NURSERY, SITKA STATION.

Mr. Rader succeeded in hiring a team at $15 a day to use in breaking the newly cleared ground. Everything is thus in readiness, and next year we shall have at least 3 acres on which to make further tests. The clearing will be extended next year, but it is evident that with labor at $6 a day and team hire at $15 a day we shall be compelled to make haste slowly.

## REPORT OF S. A. CALDWELL ON COOPERATIVE EXPERIMENTS AT WOOD ISLAND.

Wood Island, Kadiak, Alaska,
*September 20, 1904.*

Dear Sir: I herewith submit the report of the agricultural work and experiments for this present year. The planting and caring for the crops were done by Rev. C. P. Coe until the 1st of August. At this writing I shall be unable to give final, definite results in many cases. Because of unfavorable weather, the results are far below that of former seasons. There has not been a day that the thermometer has reached 70° F. All the stable manure made on the place was used, besides other fertilizers.

### FIELD CROPS.

*Barley.*—Five varieties of barley were sown April 18—Giant Beardless, Silver King, Home Grown, White Hulless, and Twentieth Century. Made thin stands and have grown to the height of 2 feet, with short, thick heads. The head is long and heavy. There is but little difference in the above varieties, which were sown on sandy land. The Silver King takes the lead. All will mature.

*Oats.*—Several plats of land were sown to oats, with good results. The stand was good and grew to the height of 4½ feet, with heads 6 to 9 inches long, well filled, but will not mature. Had the weather been more favorable the crop would have been large. The following varieties were sown: Salzer, Prolific, Big 4 (home grown). The Big 4 gave the best results.

*Rye.*—Spring home-grown Marvel White. Sown April 18. The straw is 4 feet in height, but the heads are empty. Will be cut for hay.

Winter rye on poor sandy land made a slight stand of 2 feet, with short, empty heads.

*Lupine.*—Stands 18 inches in height, very scattering. Sown on sand field which is very poor. Some of the heads will mature.

*Spurry*, *cheat*, and *sand vetch* are equally a failure on the poor sand-field. I found one spot of sand vetch which measured 4 feet from the crown. It is in bloom at this writing, but will not mature seed.

## GRASSES.

*Timothy.*—A small plat of timothy stands 3½ feet high, with long, full heads. Will yield a heavy crop of hay.

*Clover.*—Mammoth red was sown on sand field April 26. Very little can be seen as a result.

A special mixture of grass seed harrowed in on flat, sandy land with small results.

*Phalaris* (grass seed).—Sown on marsh next to lake. Result, nothing.

## VEGETABLES.

*Potatoes.*—Potatoes planted April 15 and 16 and on May 7, on sandy land, and compared with other years, are a failure. Some of those planted in April were just breaking ground on June 25, the spring weather was so cold.

*Ruta-bagas.*—Ruta-bagas were planted in old soil, well manured, but the yield will be small. Some of the largest measure 5 inches in diameter.

*Onions.*—Onions planted both from sets and seed show small results.

*Lettuce.*—Many varieties of lettuce were sown on March 26 and May 6. Has not done as well as in former years. We have a number of good heads at this writing.

*Peas.*—Peas have yielded a very small crop. The varieties sown were Horsford and Prolific.

*Salsify.*—Salsify sown May 5. Results very small.

*Cress.*—Cress has been planted in several places, but with small results.

*Radishes.*—Radishes grew well this year, being planted at various times during the season. Varieties as follows: White, Black Spanish, Chinese Rose. All did well; some of them measured 3 inches through and 1 foot long. Some of the Chinese radishes are 4 inches in diameter, but short. These will become larger if the weather holds favorable.

*Turnips.*—Turnips are a failure. Very little of the seed germinated, and those that did produced very small roots.

*Kale.*—Kale planted in garden in old soil well manured has done fairly well.

*Cabbage.*—Cabbage plants set June 15 have large, broad leaves, but will not head.

*Beets.*—Beets have not done well this year.

*Carrots.*—Carrots sowed in drills March 26, May 5. Many of the seeds did not germinate. The others are small. Some of the largest would measure three-fourths of an inch in diameter and 4 inches long.

### FLOWERS AND TREES.

We have had the usual success with flowers. Poppies and pansies grew to a large size.

Raspberry and currant bushes planted May 2 are looking well.

Two apple trees—an Astrachan and a June Red—show a slight growth.

### LIVE STOCK.

Notwithstanding the lack of proper facilities for taking care of stock in the winter, the animals came through without loss. The pastures being fenced, kept them from the cliffs.

The cows have done as well as usual. Three of the five are giving milk. For the month of July we received 2,800 pounds of milk, which is fully as large as during any month of the year. Increase: Three calves.

But little profit was received from the Angora goats this year. Early in the spring their fleece became loose, and a large part of the mohair was lost. However, they did better than last year relative to increase, since we have an addition of four to the flock.

Relative to poultry, the hens and chickens have done well, supplying the home with eggs, and a large increase in chickens.

The duck house having been moved early in the spring, the ducks have not laid eggs, and thus we have had no increase with them. We hope they may do better another year.

The flock of geese, proving to be all ganders, were slaughtered for the table.

S. A. Caldwell,
*Acting Superintendent Kadiak Baptist Orphanage.*

Prof. C. C. Georgeson,
*Special Agent in Charge of Alaska Investigations.*

### REPORTS FROM SEED DISTRIBUTION.

Only a few reports of the results of the seed distributed in cooperation with the Bureau of Plant Industry have been received at this writing, and they are for the most part reports of failure, or partial failure, caused by the cold, wet summer. Grains of all kinds were almost total failures everywhere. Potatoes have ranged from failure to a fourth of a crop. It has been too cold for cabbages, cauliflower, and onions. Carrots, lettuce, radishes, and turnips are the only crops which have been generally satisfactory, and even these have been partial failures in many places where they generally do well.

I submit also a few of the belated reports for 1903, which have a general interest.

I would call attention to the reports of J. F. Karshner's farm, on Baker Creek, a tributary of the lower Tanana. One of these is by Mr. A. H. Monroe, of Rampart, and refers to the season of 1903, and the other is a report for the present season by Mr. Karshner himself. Mr. Karshner has located a homestead near certain hot springs in the valley of Baker Creek. He has found that a considerable portion of his claim is a natural hotbed, the source of the heat being presumably the same as that which keeps the springs hot. The possibilities of these unique conditions have not been fully tested, but aside from hardy vegetables he has so far succeeded in growing Lima beans, wax beans, squash, and cucumbers very successfully. A photograph of the Lima beans, which unfortunately is not clear enough to reproduce here, shows that they made a splendid growth and climbed to the top of tall poles. Mr. Monroe states that he found turnips and ruta-bagas in the ground where they grew, not frozen, although the thermometer registered 62° F. below zero at the time. All Alaska gardeners will watch Mr. Karshner's operations with interest.

I beg also to call attention to the letter from Rev. John W. Chapman, of Anvik, as regards the gardens by natives and whites at that place.

*T. H. Friedler, Gravina, Alaska.*—I have received, from time to time, seeds from you, and I suppose you expect me to report my success in crops.

I have one-half acre under cultivation. This (1903) was the second year. The first year I did not expect to raise much, and raised less. This year I tried some manure experiments. I tried about all the hardy and some half-hardy plants—cucumbers, beans, etc. On unmanured land everything without exception was a complete failure. One patch on which I put lime burned from clam shells, at the rate of 1 bushel to 3 square rods, did not show any improvement at all. I think the lime is slow in acting on account of not being burned enough. I am not a limekiln man; I do not know how to best burn this lime. I built a pile of logs and put the shells on top, and then more logs and more shells, and then set it on fire. But the shells packed together and did not get hot enough inside the pile.

Hen manure improves the land some, but not near as much as I expected. I had one patch on which I put the manure from 100 hens; five months' gathering on 10 rods. This manure was mixed with dry muck, and was in the henhouse until used, and had no cutworms. Radishes, turnips, and cabbage did fairly well. The rest of the things were a failure. But everything did better than on unmanured ground.

Wood ashes put on at the rate of 1 bushel to 2 square rods did better by far than either lime or hen manure. I had only 6 square rods of this, but grew more turnips on it than on about 35 square rods outside this plat that was seeded to turnips. I noticed that the leaves of the turnips on the land manured with ashes were yellow, and where the hen manure was they were dark green and more stocky, but the roots on the soil fertilized with ashes were three times as large. I had some 8 inches in diameter. Am sorry that I did not try more of a variety of plants on ashes. Besides the turnips, I had one hill of cucumbers, and they were fine. On hen-manured soil cucumber vines were only 6 to 8 inches long, with no fruit at all.

In the soil fertilized with ashes I also planted some soy beans I got from a friend in Michigan, but they came here too late. I planted them some time in the latter part of July. I do not know the exact date. I never expected anything to come of them. They were in a package from New York, marked "Early Soja Beans." Well, they grew 2½ feet high, but did not ripen seed; were frosted October 2; but they did so much better than I expected them to do in this climate that I will try them again. The cutworms got hold of the beans and a row of parsnips, both of which were good. Early Red Valentine beans ripened seed.

For a long time I did not know what was eating the plants; thought maybe it was the birds, and would sneak out in the evening with a shotgun, but never got a shot. One evening late I noticed the worms and tried to catch them, but there were so many I did not make any headway, and noticing a few very prosperous toads there I spent an afternoon and caught all the toads I could find, about 60, and dumped them on the ground where the worms were. They fixed the cutworms in a hurry, but it was too late as far as the crop was concerned.

I sowed some winter wheat last fall, about 2 square rods, fertilized with ashes (very little), and hen manure this spring. It made a good stand and did not winterkill. It got about 3½ to 4 feet high, and was ripe about August 10 to 15. Was a very good crop, and I think we can grow grain here.

A few scattering oats and barley grains that were in the sacks used to pack manure in came up and looked very good.

I intend to try a sack each of potash and phosphate next year, also more lime.

My ground is about one-fourth of a mile from the beach, and seaweed is too far to pack. This ground is muck or peat. It is something new to me in the shape of soil. It seems to be composed altogether of rotten moss or of other vegetable matter. It is covered with from 1 to 4 inches of moss, and has quite a growth of grass on it; no timber except here and there a scrubby black pine. This muck is from 8 inches to 1½ feet deep, underlaid with a gravel formation. It is full of bog holes and quite wet, but on being spaded it becomes perfectly dry without drainage. Subduing this soil is not what it is cracked up to be with spade and hoe. The sod is tough and it rots very slowly. A breaking plow and disk harrow are what it wants.

*J. S. Seatter, Juneau.*—I do not think it is best to report on vegetables this season (1904), for everything is almost a failure. We raised lettuce, radishes, a few carrots and cauliflower, and about a third of a crop of potatoes; no cabbages.

I hope you know of something that will kill the cabbage maggot; they ate the crops as soon as we had a few dry days. I tried everything—potash, nitrate of soda—but did not seem to do any good. There must be something that will destroy them. We have another insect that destroys the young plants in the hotbeds in the spring.

*Christian Krogh, Juneau.*—I received the seeds, for which I am very thankful, and I will give you the full account of every variety grown during 1904.

Lettuce, radishes, peas, ruta-bagas, and carrots all did well. Beets and turnips went to seed. Onions and parsnips hardly came up. The parsnips came up the 1st of September and some did well. Carrots did the best of all. Our garden was the best private garden here. It is the first year of cultivation.

There is one thing that troubles us greatly here, and that is a small maggot that destroys the roots of turnips and ruta-bagas. If you can give me any advice how to get rid of them I will be very thankful to you.

I would like to plant some gooseberry and currant bushes. I have a few bushes now, but would like to plant some more. Will you let me know what varieties you think will do the best? I am also thankful for the report which you sent me. Some one sent me a few seeds not long ago, but they are not the right kind. I would like to ask you for some potatoes that you think will do well in Alaska.

Some of my carrots measure over 1½ inches across the top and are about 5 inches long.

*B. H. Hefele, Skagway.*—I will try to give you an account of the experiences I had the past season (1903) with the different varieties of seeds you sent me, and some seeds which I got from Bohemia.

The frost did not come out of the ground before the first part of May. I could only plant the vegetables all out by May 15, and then the frost was not out more than 12 inches.

I raised a lot of different plants in a hotbed, and planted the same out in the open air about the latter part of May. They were red beets, onions, cauliflower, cabbage, some virsing (a Bohemian vegetable, which heads like cabbage, but has the taste of kale), and some celery. I seeded lettuce of three different kinds in the open ground and had splendid results. My wife and I are very fond of lettuce, and we had it almost every day from the middle of June until September, just cutting above the root, and we had a new crop in two weeks. The red beets did very well, and from July until now we have been well supplied; in addition, have about 40 plants weighing in average about 2 and 3 pounds, all clean, and not in the least woody. Broad Windsor beans did fine, and I had quite a time to stop them from growing, but they never matured. I had worse luck with a row of Bayo (?) beans. The slightest cold wind turns the leaves black. Carrots, turnips, parsnips, and ruta-bagas did fine, but radishes were terribly wormy, so we could not use them at all. The cabbages and cauliflower were bothered with maggots, which ate the roots off about 1 inch below the surface. I used air-slaked lime with good success, and my neighbors after me. Celery was splendid, and there was none finer anywhere.

I had my ground all well manured with horse manure, which was not rotted enough, and we were all troubled on this account with a splendid crop of weeds, and I had all I could do to keep them out of the beds. I have had the ground in cultivation for four years and have always had plenty of manure, and last summer a half barrel of air-slaked lime.

I have only the evenings for my own use, so it is pretty hard to do any gardening for profit, but, in spite of being very short on time, I raised enough for our own use and some of our neighbors—in fact, more than my wife and I could consume—from a place about 25 by 50 feet.

I am keeping also a nice lot of chickens, and I made from an average of 20 chickens in 1902 a very nice profit, getting about 3,000 eggs during the season, besides the young chickens and fowls which I killed and sold. I figured out to have a clear profit of $104, the feed being mostly scraps from the household.

We also had a nice lot of flowers—pansies, mignonette, asters, bachelor buttons, marigolds, nasturtiums, geraniums, pinks, and carnations—all from seed in open ground except the first two varieties, which we started in the house.

I hope that these few items will contribute to the progress of vegetable farming in Alaska.

*H. D. Clark, Skagway.*—Your letter of October 7, 1904, was nearly two weeks in reaching me. I hope this report will reach you in time for your report, since you desire it. I have very little of good to report for Skagway in its vegetables and flowers this year. Potatoes, as a rule, were about one-fourth of a crop. Cabbage was practically a failure. A great many of the growing plants died after setting out, either from worms or cold weather. A great many of those that lived have failed to head. From a 2½-acre cabbage patch we got less than 2 tons of cabbage. Beets are very poor, and parsnips below the average of other years. Carrots are a good crop, as a rule; from one patch of 18 square rods we harvested 2,200 pounds. Celery is also a good crop.

The season has been very dry and cold. The flower gardens have had a hard time. Dahlias, asters, and other flowers which have grown and blossomed luxuriantly other years have scarcely blossomed at all this year. We hope for different weather next season.

We find it almost impossible to raise either turnips or radishes on account of worms. Have you found any means of doctoring them successfully? We tried a soap and crude carbolic-acid emulsion with no satisfactory results.

I have bought Mr. Nicolai's interest in the Skagway ranch, and am putting up a 100-foot forcing house and intend to stay by the gardening business for a few years at least.

*Rev. William L. Carle, Hoonah.*—My garden this year (1903) was the best of any year so far. The following did nicely: Ruta-bagas, beets, turnips, lettuce, seed onions, radishes, cabbages, peas, rhubarb, and carrots. Beans did not do so well, as the ground was so dry that they were slow in coming up, but we had several messes. We also had an abundance of flowers—sweet alyssum, candytuft, poppies, and nasturtiums. I planted more seeds, but the ground was so dry that they did not germinate. The past summer was the driest ever known here. But I covered my garden heavily in the spring with seaweed and dug it under as best I could with a spade; result, the best garden in spite of the dry weather. My largest cabbages weighed 6 pounds, and ruta-bagas 2 pounds each. Some of the natives had ruta-bagas as big as three of mine.

I made a few experiments. I found that rhubarb grew three times faster simply by having a box with top and bottom removed laid around it. I began with a few plants, or rather, my wife did, while I laughed at her for her trouble, but I soon was converted to the plan and covered the whole number. I also found that to take onions and cut off for use all but the center and then to plant the latter, gave nice tops very quickly. I planted potatoes in the house and when the plants had made stalks 6 inches high I set them out in the garden. They made nice potatoes. I planted some potato parings, but the ground was so dry they did not sprout for some time, hence did not do very well. But I judge that parings are as good seed as pieces of potato.

I tried to ripen peas for seed, but am not sure if I succeeded, but I am inclined to think that they will grow. I had a few potatoes which grew from seed left in the ground of last year's crop. They did better than those planted. Would like to know from others if they plant Alaska-grown potatoes, or import seed each year. I believe some one should develop an Alaska strain of potato.

I planted my first garden May 6, and had lettuce and radishes June 30. May 25 I picked the first rhubarb. I planted radishes again July 14, which grew quickly, and we had great numbers to give away. We also gave away a large amount of lettuce, and almost every sailor that came into our harbor carried away a bouquet of flowers. Ruta-bagas, turnips, and cabbages, etc., stayed in the ground until October 24. They had been covered with 8 inches of snow in the meantime, but without damage.

*Mrs. J. Gavigan, Valdez.*—Following is my experience for 1904 with the seed which you so kindly sent:

Nothing grows better than kale, either Improved Siberian or Tall Curled Scotch. Grows rank as often as cut; winters without protection; supplies first early greens in spring and seeds second summer. I have never seen a worm in it. Rhubarb also does well. My Champion ruta-bagas, planted in May, were in September 5 and 6 inches through. Early Jersey Wakefield cabbage and Early Paris cauliflower, started in the house, headed up pretty well, especially cabbage. Beets and Scarlet Horn carrots reached medium size. White turnips and all radishes are subject to a small maggot. I prefer small olive radishes, which grow quickly; if let remain in the ground they get wormy. I think everyone agrees that the Round Yellow turnip is far better than the White or Purple-Top, as it keeps better, is rarely wormy, is not peppery or watery, but crisp and sweet, like an apple, to eat raw. Our White turnips grow readily with but little care and reach a great size, but they are poor. Improved White Plume celery grew 15 inches high the second summer. The tall peas planted in rich soil ran all to vine and the few pods failed to fill before frost.

Of flowers, I find the pansies do the best for this rainy climate—bloom the second summer. Shirley poppies, fall sown, failed to come up; but May sown did well. Saponaria and Collinsia did well, but Xeranthemum and Gaillardia failed to grow. Sweet peas I have grown for two summers, but they are almost worthless, blooming, if at all, only a few days before frost. Our season is so short here that most annual flowers are not worth the trouble. I think perennials are better.

*A. Lawson, Sunrise.*—Looking over the weather reports you will see that the weather during 1904 has been cold and unfavorable for agricultural pursuits. I have just dug my potatoes and find that where I should have had over 4 tons, according to the yield of the three or four previous years, I got only about 400 pounds salable tubers, and, perhaps, as much more of small ones fit only for stock feed, scarcely worth gathering.

The greater part of my cabbage and cauliflower plants were destroyed by rabbits in June, and what I was able to save have grown slower and smaller than in former years. All my peas were a total failure, none maturing sufficiently for use. Turnips, lettuce, and radishes abundant and of good quality. Beets, carrots, parsnips, and onions rather small but otherwise tolerably good.

The winter wheat I planted last fall from seed you sent grew very nicely and headed out, but was beaten down by the heavy rain that fell August 11 and soon began to mold and rot, and so I had to clear it off the ground. The rye grew very well and was harvested September 24. I am now drying it and intend to use it for seed next year.

I presume that the weather has been unfavorable in other parts of Alaska, because the natives informed me that they never experienced such a cold and disagreeable summer before.

*Dan Dougherty, Uyak Bay.*—I am sorry to say that my garden has been a total failure this season (1904), as we had no summer. I planted 240 pounds of potatoes and will not get back the seed. Not even a radish.

*Capt. J. Ducan, Mine Harbor, Herendeen Bay.*—In a previous letter I wrote you that I was not expecting a good result of my gardening experiments, but to-day, alas, I regret to say that it was nearly a failure. Was it the gardener's or the climate's fault? It may be from both, but I dare to say that the former tried his best among the numerous difficulties he encountered, when, on the other side, the climatic conditions, jointly with poor soil, offered a serious obstacle to success.

Circumstances were bad. I had first to clear some brushy, rocky ground, which was a light sandy loam; the mold part of it was only 4 inches thick and when tilled the soil was of poor quality. Fertilizers should have been added, but I had just enough to make a cold bed. I started the work as early as the end of April, when snow was yet covering many places around.

A cold bed of planks was placed against the kitchen wall, facing west exposure, and was filled with 1 foot of manure, covered with 8 inches of dirt. I had muslin sashes made to protect the bed at night; this proved to be a sufficient protection against late frosts. In that bed I sowed a variety of vegetables, which, except cabbage and kale, grew very poorly.

During the first week of May I sowed in the garden (divided into beds) all kinds of seeds, which took from fifteen days to one month to sprout. The trouble started with ground squirrels, which, ignoring my anger, were digging and eating the precious little sprouts. Savage war was declared on them, and with guns and traps I did exterminate hundreds of them.

However, part of the young plants were saved, and every day I was trying to ascertain an increase in their size, but this was in vain, for they nearly all reached 1 to 3 inches and died, excepting radishes and turnips, the latter growing as large as oranges.

Three times I transplanted cabbage and kale from the cold bed in the open but every time squirrels were feasting upon them. The cabbages that I saved grew in cold bed, but did not form heads. Kale also raised in cold bed grew vigorously.

Of flowers, mignonette, pansies, cornflower, and ten weeks stock were in bloom before killing frost. The others, like the vegetables, showed their leaves and died.

Now, about the most interesting branch of agriculture—wheat, barley, oats, and potatoes—I will make a special mention. Wheat with difficulty showed itself with poorly formed heads, and did not mature. Barley, though having good size, did not have a chance to mature, and was frozen before formation of the kernel. Oats were in better shape than the rest, reaching 3 feet high, with a vigorous growth. Kernels were formed and needed only a few sunny days to mature, but frost came instead, and everything was lost. On June 12 I planted some potatoes with manure underneath, and when frost appeared I harvested quite a lot of small tubers, the largest being the size of a chicken egg.

As a conclusion, and considering all phases of my first experiment, I am induced to believe that under better circumstances, and having a three or four years' well-fertilized soil, the chances to obtain some products from the soil should be greatly augmented, but I do not think that under such conditions a farmer would make a sufficient living out of the soil to decide to live permanently in this desolate part of Alaska.

Having a little part of the seeds left I may try again next spring, and in that case I will have the pleasure to tell you the result of my second experiment.

*M. A. Davis, principal public school, Unalaska.*—The garden seeds you so kindly sent me last spring, regardless of unfavorable conditions, did well during 1903 with few exceptions. The season was not all that could be desired, and then we were not prepared to plant them as soon as they should have been planted, owing to ill health and a change of residence at planting time. However, the lettuce, kale, cress, turnips, radishes, spinach, rhubarb, asparagus, and parsley did very well. Next season we can probably do better, as we have fenced in a small garden, and have put in a generous quantity of barnyard manure in heaps upon it for next spring.

Much of the flower seeds sent me was given to the natives, who take great pride in flowers. Many of the homes in the village have flowers growing and blooming from old tin cans, etc., in the windows. Near the schoolhouse is a native lady who has a fine pot of nasturtiums blooming in her front window.

Few of these natives have any relish for vegetables, except turnips and radishes, but most of them love flowers.

*Rev. J. H. Schoechert, Quinhagak, Kuskokwim Bay.*—Your favor of March 1, referring to the seeds sent, came to hand too late for use this year, 1904. Nevertheless, we have a blooming garden, a surprise to whites and natives alike, here on the coast of bleak Bering Sea.

We sowed our seeds and planted the potatoes from May 10 to 30 in the garden, while the hothouse was planted much earlier, so that by the middle of May radishes, lettuce, and cress were available for table use.

You refer to sharing seeds with the natives. This has always been done, the natives can get all the seeds needed, and the use of tools, etc., from the mission at any time.

As I found out by past years' experience, when inquiring of said inhabitants "Why don't you make gardens?" their common plea was, "We have nothing to make a fence to keep the dogs out." Consequently on our return from the States we brought sufficient wire to make two gardens. In part of one the natives can use all the ground they want. At least eight have small patches of ground with turnips, radish, ruta-bagas, etc. As they were a little slow about getting started, the mission garden was far ahead of theirs. On seeing how ours was cared for, watered in June, which was dry, and by giving them various pointers, they began to try to help theirs along. It was a pleasure to see men, women, and children carry water to water them—to watch them daily. Later on we had plenty of rain and now things are thriving.

It surely is one of the best means to help these people to procure a living by tilling the soil, and to prevent their becoming paupers, looking for rations from the Government when the game of the country is killed off. It no doubt will be slow work to see extensive gardens by them, yet when we remember how long it took the Indians in the States to take to farming we have every reason to take courage. Yes, I venture to say the Eskimos will pick it up more readily, being of a thrifty nature.

*J. Hinz, Ogavik, Kuskokwim River.*—Many thanks for the seeds you kindly sent me this year, 1904. I received them at the end of July at Bethel. Next year we will use the seeds here at Ogavik and report the results to you.

During the two years I have been in Alaska I lived at Bethel. The gardens there are pretty good. Last year we had excellent potatoes, turnips, cabbage, cauliflower, and many other vegetables. The potatoes were far better than those we received from San Francisco. (Pl. XII, fig. 1, show vegetables from gardens at Bethel.)

They have also been quite successful in gardening here at Ogavik. It seems the soil is very rich. This year the garden does not stand so very good, but the vegetables are better than we could expect.

As no missionary was living here last year the garden was not planted. This year I came up from Bethel on the 1st of June. With the help of some natives I prepared the ground, but it could not be done sufficiently. On June 3 we planted some potatoes, turnips, carrots, cabbage, onions, radish, lettuce, and other vegetables. After that I left Ogavik, and the garden was without care, for the natives, too, left the place, going to their fishing places. On August 3 I returned, and when I saw the garden I could scarcely see any vegetables, for grass and all kinds of weeds covered them. After having been cleaned, potatoes, turnips, and carrots recovered and grew nicely, but when the potatoes were flowering the frost killed them, August 26. They are still in the ground, also turnips, carrots, and onions, which have done pretty well. Radishes were already too big and old when we arrived here. The cabbage—Stone Mason—did not head. At Bethel we had Early Jersey Wakefield, which did very well.

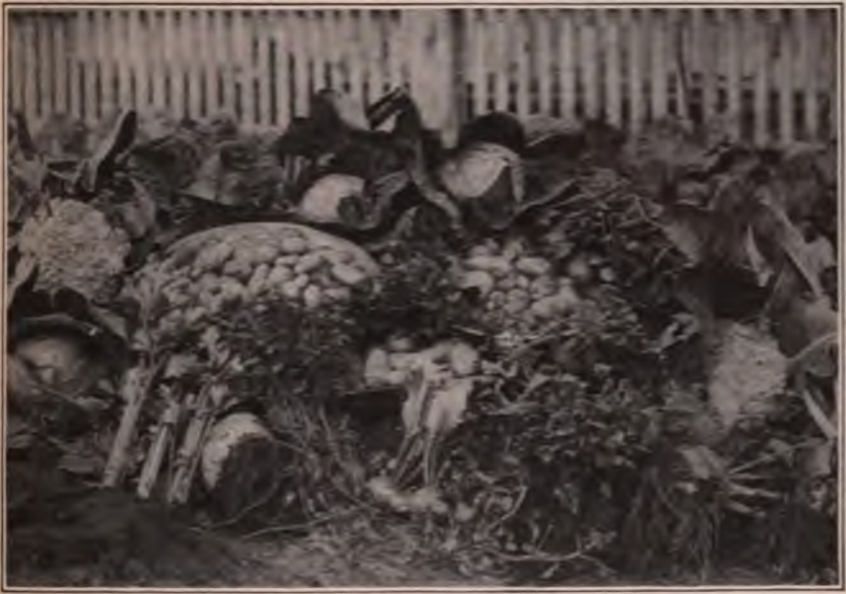

FIG. 1.—GARDEN VEGETABLES GROWN AT BETHEL, KUSKOKWIM RIVER.

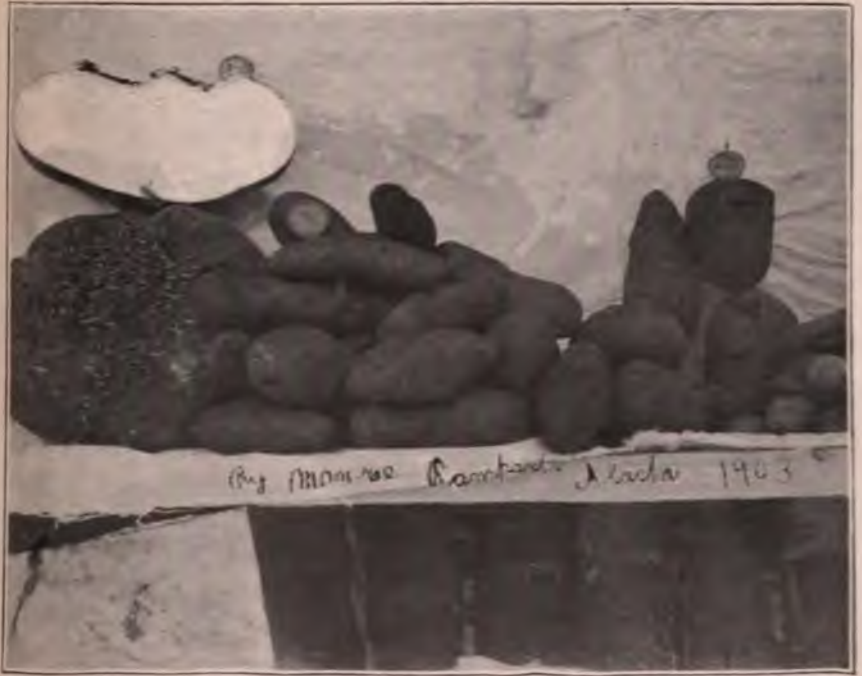

FIG. 2.—TURNIPS, POTATOES, CARROTS, AND CUCUMBERS FROM J. F. KARSHNER'S FARM, BAKER CREEK, TANANA.

*John W. Dobbins, Nome City.*—Many thanks to you for the garden seeds, which I received February 4, 1904. In reply to your request, I shall now endeavor as briefly as possible to give you a detailed account of my experiments in Nome, Alaska, since the year 1900, in growing vegetables, flowers, and grasses.

I arrived in Nome on July 28, 1900, and I have remained continuously ever since. I secured a town lot 50 by 150 feet. I built a cabin and spaded up the ground thoroughly. By chance, or by hustling, I found a lady who had one package of turnip seed, one package of beet seed, and part of a package of radish and lettuce seed mixed. I secured and planted these seeds on my lot. They grew wonderfully rapid and produced an abundant crop. It was a surprise to everybody to see them grow in Alaska soil in this northern latitude. They were the first garden seeds planted in Nome.

I also bought and planted 80 hills of potatoes. The young potatoes developed in size from marbles to that of a turkey's egg. I also planted 50 onion sets, which grew almost beyond description. The result was so satisfactory that I sent to San Francisco, Cal., for a variety of garden seeds, flower seeds, and grass seed for the spring of 1901. Most all the varieties, such as radishes, lettuce, peas in three varieties, beets, onions, cabbage, spinach, kale, parsley, cauliflower, carrots, parsnips, celery, etc., made a rapid and enormous growth. I used and gave away to the amount of about $75 worth of vegetables and flowers to visitors who called to see the Alaska garden, as they called it. The plants from California seed will not or did not reproduce and mature seed.

To fully determine if any seeds would mature in this climate I sent to New York and Detroit, Mich., for seeds for 1902. The result was far better than from the California seed, but only peas, spinach, French mustard, and radish seed matured.

All experiments thus far were in the open air. Beginning as soon as the ground could be worked in the spring, I prepared the ground in many ways. In some cases I used stable manure and native tundra; in other cases, sand, manure, and tundra; in some cases, wood ashes and black sand; in some cases, slaked lime and native tundra, and in some cases an intermixture of all; but in each case the result was good. I used pure spring water from the Nome City waterworks, through iron pipes.

Early York cabbage made some heads of good size, firm and crisp; price in the Nome market, 25 cents per pound, and ready sale. I used and gave away to visitors fully one-half of the experimental crops to encourage an interest in gardening and sold $155 worth off a lot 50 by 150 feet for the year 1902. I have bought another 50 by 150 feet adjoining the first one, and built a hothouse for the forcing of plants—not in the old-fashioned way, but by electricity—for the year 1903–4.

I have been corresponding with many reliable seed growers in the States—with some in Washington, D. C., with yourself, and with others elsewhere—and have obtained many reliable pointers, information, and varieties of domestic and foreign seeds and grasses. I have procured several varieties of flower and grass seed from Norway and Sweden, which have grown well this year (1903). I also planted red clover, white clover, timothy, redtop, bluegrass, orchard grass, lawn grass, and millet seed in many kinds of soil, every one of which grew rapidly, and the result was entirely satisfactory, especially red clover, timothy, and Norway grass, which will average from 2 to 3 feet in height and yield, I think, from 1½ tons to 3 tons per acre with ordinary conditions. Hay (timothy) shipped to Nome is now selling for $50 per ton.

I have a water pipe laid through the center of my experiment ground connected with the city waterworks, which supplies water perpetually during the spring, summer, and fall months. It cost me $100 for the pipe and labor of constructing it and $10 per month for the use of the water continuously. I have a 65-foot hose and two faucets so arranged as to spray on water rapidly or at leisure.

The experiments and results I have thus far shown have created in the minds of many of the Nome residents an interest in beautifying their homes by planting vegetable and flower gardens. A number of small gardens were planted, with successful results in many instances.

The vegetable seeds I planted for the year 1903 are as follows:

Radish—Long Scarlet, Small Round Scarlet, Half Long Purple, Black Spanish, and Snow White. Long Scarlet and Long White were the choice; they sold for 50 cents per dozen. Lettuce—Grand Rapids, California Cream, and Hanson; Grand Rapids the choice; 25 cents per dozen. I sold 400 dozen lettuce plants at 25 cents per dozen and 100 dozen radish at 50 cents from 6 beds of 8 by 8 feet. Cauliflower—One small package of seed produced about 150 strong, healthy plants. They made an enormous growth, but only 2 heads formed, transplanted late on account of a cold, late spring. Sold for chicken feed. Cabbage—Early Dwarf York was propagated by electricity in greenhouse and transplanted late, made a rapid growth, but only a few heads proved of superior quality. Cabbage in Nome market sells for 25 cents per pound. Peas—American Wonder (dwarf). This pea does not deserve its name. The rows were a solid mass of pods and the pea as sweet as sugar. Alaska Prolific was a good producer, but not as good as the American Wonder. The Giant pea, 6 feet high; a good producer, but requires poles or frames. Sold for chicken feed. Asparagus—About 50 roots from this year's planting. Celery seed failed to grow. Parsley grows well, price 25 and 50 cents for a small bunch. Spinach grows well, ready sale at a good price. Carrots were of slow growth, but produces well at end of the season. Parsnips—The same as carrots. Onions (Red) do well from seed and sets better. Mustard grows prolific; ready sale in early spring. Beets (Long and Round) do well; will be a success. Sweet corn grows slow; will not be a success. Cucumber was a failure this summer; did not blossom. Tomatoes were also a failure. String beans were a failure; rotted in the ground. Turnips were excellent in growth and taste; a success. Potatoes were of average size and good flavor; will be a success. Ruta-bagas were a wonder in size and taste; excellent.

Flowers of almost all varieties flourish and bloom in this latitude. I had only three sunflower seed, which I planted, and each produced a plant of good size; both stem and flower, but no seed matured. Pansies did well, many plants in bloom; a success. Stock and candytuft were also a success. Larkspur did well, many plants in blossom; a success. Crimson flax (grandiflorum)—Plants in blossom; a success. Lobelias (in baskets)—Plants in blossom; a success. Nasturtium—Splendid; plants in blossom; a success. China aster seed failed. Bachelors button—Splendid; a success. Marigold (Norway)—Not a success this year. Arctic mint (native)—Sweet odor, small blossoms; excellent for borders.

Strawberries—I imported 250 plants, but they were damaged in shipping and failed to grow.

Rhubarb—12 roots; 9 lost in shipping.

Not one berry nor fruit tree has been introduced in Nome so far. Only three rose bushes in Nome so far to my knowledge. All things being favorable, I wish to experiment this year (1904) in berry plants, such as blackberry, raspberry, strawberry, and gooseberry, and hop vine, and also a few fruit trees and currant bushes, rose bushes, and ornamental shrubs.

Wild blueberries grow abundantly here, and thousands of varieties of beautiful wild flowers.

Grasses of the following varieties do well: Red clover—excellent; from 18 inches to 3 feet high; strong root. White clover—very good, from 6 to 18 inches high, and strong root. Timothy—very good; from 2 to 3 feet high; thick and fine. Bluegrass—excellent; ground a solid mat; growth about 12 inches. Orchard grass—did well; thick and fine, spreading. Redtop did well; thick and fine; growth, 2 feet. Lawn grass a success; grows rapidly; thick and fine. Norway grass—starts and grows slow; coarse, kind unknown. Wild rye—will grow well; result from seed in baled hay.

These experiments have been on a limited scale, but sufficient to prove that vegetables, flowers, and grasses will be a success in many cases and profitable beyond a doubt.

*E. B. O'Connor, Council City.*—I tried to raise a little garden truck in 1904, with but little success, and as I did very well outside can not fathom the reason for my failure here. I hear that your seeds do well here, and therefore ask you to send me some. My potatoes have done exceedingly well in rich land well mixed with manure. Lettuce does well, but radishes and onions are very poor. I have good bottom-land soil mixed with manure, and I put it on a little sloping ground up from the river bottom. Seeds should reach us this fall, so as to plant in the early spring.

*C. W. Thornton, Solomon.*—In regard to seeds sent me for trial in 1904, I planted beets, turnips, carrots, cauliflower, onions, radishes, sweet peas, and nasturtiums. I distributed to others lettuce, radishes, turnips, beets, carrots, and sweet peas. All of these seeds sprouted well, and in every instance in which they were given a little care they did well, with the exception of the onions. I think perhaps that our season is too short to produce good onions from seed. The most satisfactory results were obtained from radishes and lettuce.

*J. V. O'Hare, S. J., Holy Cross Mission, Koserefsky.*—The crops in general are not so good as usual, owing to the backward season. I might also accuse the season of forwardness, for the last few nights have been cold, with a light frost during one night. Temperature, August 25–26, minimum 33°; August 26–27, minimum 36°. I fear that the oats grown from seed and matured here last season—1903—are injured by the cold.

We have now 8 head of cattle, which are furnishing an abundance of rich milk. Another addition, and a welcome one, is the chicken ranch. We have over 20, large and small. Fresh eggs add much to the cook's possibilities. However, both cattle and chickens have suffered from the savage canines in spite of many precautions.

One horse was unable to do all the work last winter, so a gentle bull was broken in and is doing so much better than the horse that he was put into the plow last spring, while his weaker rival was relegated to a small harrow.

More land is being cleared of trees and stumps and broken, so that very soon that glorious meadow you photographed will be under cultivation. The grass that you so admired for its rank luxuriance gradually declined until it was found better to begin breaking it for cultivation. Clover and timothy are doing fairly well.

Sugar beets—an experiment—poor; probably on account of the cold and dry summer, that is, the first half of the season. Squashes have blossomed and formed fruit, but will not have time to amount to anything. Tomatoes blossomed, but they did not form fruit. Cabbage suffering from worms at the roots, otherwise fair. Mangels doing quite well.

Flowers of many kinds in profusion, and are much admired as well as desired by the passengers on the river boats. One can hardly imagine himself in

Alaska when he sees the noble rose the product of the patient and skillful care of the sisters.

Our boys and girls are now out on a four-day berry picking. This is a yearly event, very enjoyable as well as profitable, as they bring home some 6 or 8 barrels of berries, mostly blueberries. Raspberries, currants, and several other kinds grow wild in abundance, free to all comers.

Down in the Yukon delta I saw this summer the most forlorn little garden in the world. After nine weeks' growth the radishes, though very good, were just becoming large enough to eat, while the lettuce had perfect heads about the size of a silver dollar. That locality is evidently not intended for a garden of Eden. On arriving there on June 1 I found the river banks still piled up with the ice from the Yukon, with great snow drifts on the bushes, and no sign of leaves on the trees. I should not say trees, for there is nothing deserving the name in the whole place.

*John W. Chapman, Anvik.*—The season of 1904 has been a long one, but cold and backward. Successful sowings of radishes, lettuce, rhubarb, peas, corn salad, and parsnips were made April 28. The peas were the Prolific Early Market, and yielded a fine crop, maturing August 15. American Wonder peas sowed May 31 set very full, but should have been planted two weeks earlier.

Wakefield and Dwarf York cabbages were planted in a cold frame April 28 and protected by glass. They were set outside May 25. The Wakefield made solid heads, while the York has just commenced to head. Snowball and Paris cauliflower were given the same conditions, and the Snowball succeeded, while the Paris failed. Rhubarb, started in the same way, has made fine, healthy plants. Radishes were ready for the table on June 6. The French Breakfast gave the best results.

A few potatoes were sent us by a neighbor from the Koserefsky stock. We ate the potatoes and planted the parings, giving them a start in the cold frame, on April 28. They were removed to new ground, turned up last spring on May 25. Fifty hills yielded 45 pounds. The size and quality were good. On old ground in Isaac Fisher's garden the same stock yielded a pound and a half, average of a row of 13 hills, dug to-day.

Most of the planting in all the gardens in this neighborhood was done between May 10 and 15. An ivory white potato from our supplies received from Seattle yielded a pound to the hill on new ground under favorable conditions. Sowings of Purple Strap Leaf turnips on June 23 are successful.

The sowings so far discussed were made in warm gulches on the north side of the low hills at Anvik. The ground was new, mostly a dark loam. Nearly everything succeeded, but beets, sowed May 24, were a failure. In a garden made by Mr. W. C. Chase, they succeeded admirably. Mr. Chase's garden is on lower ground upon which slops had been thrown out for several years. It has a southern exposure. His carrots and Early Round parsnips were also successful, though small.

Successful potato gardens were made by Messrs. L. F. Cooper and Max Simel, traders; by Mr. Chase, and by Isaac Fisher and Peter Redlands, the last two of whom are natives. Isaac Fisher's garden (Pl. XIII, fig. 1) is quite a large one, about 75 by 75 feet, and is one of the best in the place. He has excellent potatoes, White Strap Leaf turnips, Champion ruta-bagas, Wakefield cabbages, and a few Snowball cauliflowers. Some twenty or more natives made gardens, but most were poorly cultivated and weedy. Their success is enough to encourage them to try again, and the number of successful ones will doubtless increase yearly.

I take pleasure in inclosing a photograph made by Mr. A. L. Kurtz (Pl. XIII, fig. 2).

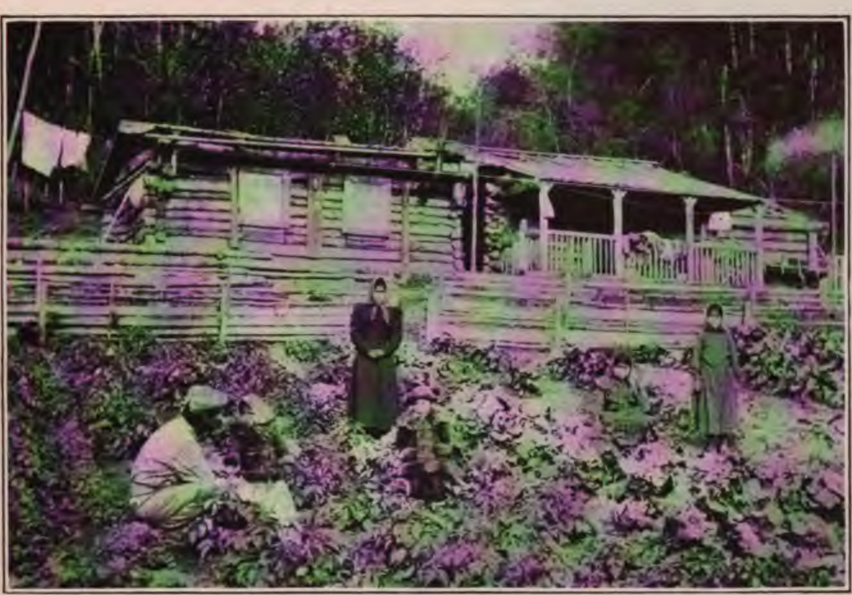

FIG. 1.—GARDEN OF ISAAC FISHER (NATIVE), ANVIK, 1904.

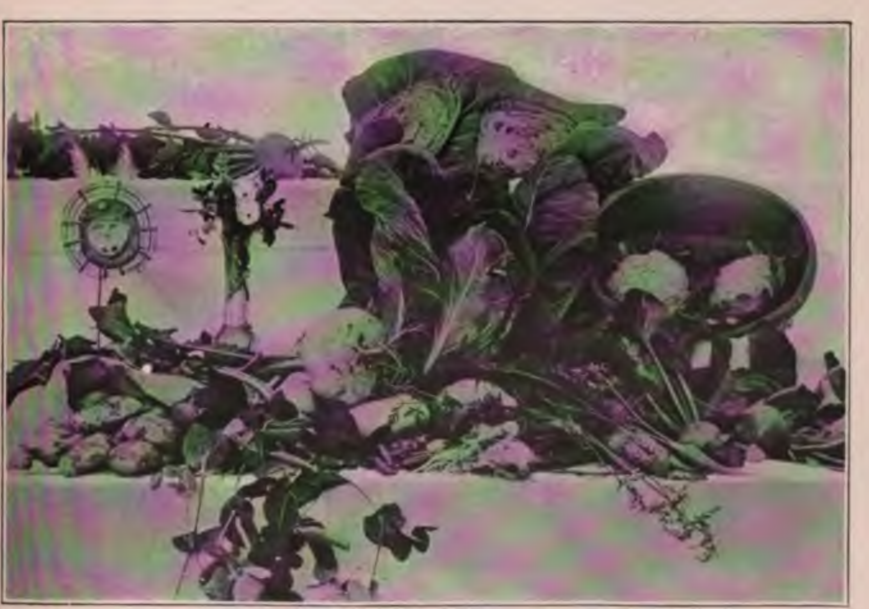

FIG. 2.—VEGETABLES GROWN AT ANVIK MISSION, 1904.

We have had great pleasure from the flowers grown from the seed which you sent. Nemophilas and candytuft in July were followed by corn flowers, pansies, mignonette, and clarkias, and stocks. The stocks were sowed May 24 and began to bloom about two weeks ago. Sweet William and Chinese pinks planted on the same date have grown well, but have not yet made buds.

Something over half a ton of potatoes were raised in Anvik this year and harvested September 17. Several ruta-bagas weighing 2 to 3 pounds were harvested, but, in general, they were sowed too late for a good result. They should have been sown as early as the ground could be worked.

*A. H. Monroe, Rampart.*—I visited J. F. Karshner's Hot Springs farm again last January and took a photograph of some of the vegetables he still had which were raised in 1903. He requests me to make a report for him and thank you for the seeds that you sent him. Of course his farm is not an average representative farm for this northern climate, for he has 200 acres of black soil that never freezes because of the heat of the earth.

The thermometer registered 62° below zero while I was there, and the wind was blowing some, yet I found turnips and ruta-bagas in the ground where they grew and were not frozen.

Mr. Karshner has settled down for life on this farm and will endeavor to produce vegetables for the miners of the surrounding country. Last year he raised more than 100 bushels of potatoes, which he sold readily at 10 cents per pound. His turnips did well, some reaching an enormous size, weighing 16 pounds and measuring 39½ inches in circumference. Ruta-bagas as large as 14 pounds, which he disposed of for 5 cents per pound. Fifty-two cabbage plants produced 52 good heads, the largest weighing 12 pounds, which he sold at 15 cents per pound. Beets, some weighing 4 pounds and sold at 15 cents per pound. Head lettuce as large as 2½ pounds.

Here is what Mr. Karshner says:

"Began clearing land October, 1902. Began planting peas, beets, lettuce, and turnips April 20, 1903. Came out of the ground May 1. Potatoes were up May 20, cucumbers, pumpkins, and beans May 26. Sowed oats June 3, and they were ripe September 5. Radishes and lettuce were large enough to eat in June. Carrots, turnips, beets, peas were large enough to cook July 4. Potatoes large enough to use August 15.

"Carrots and parsnips attained a diameter of 4 inches. Yellow wax beans planted May 26 picked August 12. Squash planted May 26 ripe September 20. Largest cucumber 9 inches long. The vines yielded well. The beans yielded well; some pods 4 inches long and well filled. Peas did excellently. Kale excellent; 2 feet high. Buckwheat planted July 4 began to fill September 15, but the rabbits ate it. Mustard did well and ripened 3 quarts of good seed. Onion seed ripened also. Radish and lettuce seed also ripened nicely."

He will have 3½ acres in cultivation this year (1904), and will plant wheat and oats of different varieties, and also clover and timothy seed if he had them. He especially wishes to try winter wheat, which he desires you to send him a sample of; also a few celery seed.

Mr. Karshner followed farming before he came to Alaska and likes the work, is well satisfied here and has no desire to return to the States. His farm will give better returns than most of the gold mines for the amount of labor put onto it, in this camp.

The season was exceptionally dry, so that some gardens dried up. The rabbits destroyed nearly everything I planted last year. Wheat did not mature here, but the grasses did well, and timothy headed out a little. The rhubarb got so late a start that if it lives will do well this year.

I believe that some varieties of crab apples would grow on Mr. Karshner's place, because service berries do well and grow abundantly over there.

*J. F. Karshner, Magic Hot Springs, Baker Creek Station.*—I inclose report of agricultural work for the season of 1904. Owing to your request to have my report early I can not give you full report, but will send in later a few lines.

The weather has been rather cold and backward the whole season. At present and for the last two weeks it has been raining, somewhat after the fashion of the weather along the coast of Washington, which made my cabbage burst, especially the early kinds. This being the second crop on some of the ground, I find it doing much better than last year. You will see by the dates of planting that the cabbages vary considerably, some being early, others quite late. I have no team as yet, and grubbing is rather slow, but I hope to do better next year.

However, everything is doing well. The growth is quite rank. I got a few small packages of Romanow wheat and Manshury barley, and also buckwheat, all of which I seeded. At present barley is ripe. It stands about 4 feet high, and I never saw better barley. The wheat is about the same height, but later; it is in the dough at this writing, and looking fine. The buckwheat is about 2 feet high, and filling nicely, and I doubt not but that it will mature all right. I will send you samples later.

I received the winter wheat and other seeds which you sent me in due season. I will sow the wheat the first of September, and next spring I will try the oats, etc.

On April 18 I seeded cabbage, celery, cauliflower, and broccoli on the slope of the hill which is warmed by the heat from the springs below. All came up well. May 20 I transplanted Early York and Jersey Wakefield cabbage for early marketing, and July 20 had heads that weighed 4 pounds. The late cabbage was transplanted June 6, and is at this writing heading finely. The early cauliflower is now on the market; the heads are large and fine, some weighing 4 pounds. The heads of the early cabbage are bursting. Late cabbage is not bursting much, and the celery is looking fine.

On April 20 I seeded turnips, lettuce, radishes, and rhubarb. The turnips (Early Milan) were large enough to cook June 2. Lettuce and radishes mature very quickly here, and I sow a little of both every few weeks for table use. The rhubarb is growing nicely and I think it will do well here.

On April 28 I noticed some volunteer potatoes coming up, and they had new potatoes fit for use by July 4. May 7 I planted potatoes in the field, and they have done well, in fact far above the average. I had some that weighed 2 pounds each. The crop planted at that date has already been marketed. Potatoes planted May 30 are about out of bloom at this writing and doing well. June 14 I planted more potatoes, and they are in full bloom at this date.

May 10 I planted Broad Windsor and Early Red Valentine beans. Both are doing well and I think that they will mature. On the same date I planted cucumbers and Golden Wax beans. The cucumbers are looking well and full of small fruit, and the Wax beans are loaded with pods and I think will be large enough for use, as were some I planted last year.

May 25 I seeded Half Long carrots, Early Egyptian beets, Hollow Crown parsnips, and Champion ruta-bagas. All of these are doing finely.

May 10 I planted peas, the variety called "Earliest and Best," and I had peas for July 4. I planted a succession of peas, and three crops are ripe. I shall have plenty of seed for next year.

June 18 I planted turnips, kohl-rabi, ruta-bagas, and summer squash, and all are doing finely. The seed of the squash was late in coming, hence the late planting, but they are filling out very well at this date, and I shall have at least a few large enough to cook.

May 27 I sowed some tomatoes. This is too late for good tomatoes, but they have made a heavy growth and are in full bloom at present.

I measured some of my second sowing of turnips, and some of them measured 29 inches in circumference, with plenty of time to grow yet.

I expect some large cabbage from my Late Flat Dutch and Drumhead varieties, but will report on these later.

It is somewhat as you say about the ranch I have being better than a placer claim. I did not appreciate it until this year, but all the crops have done better than last year, in spite of the fact that this has been a cold summer; but cold or hot, dry or wet, I see but very little difference; only a longer and heavier growth when too wet. (Pl. XII, fig. 2.) I have cabbage leaves that measure 26 and 30 inches.

The potatoes I planted are Burbank, but by looking at them since they are grown you would not know what variety to call them. They resemble some I had in Washington, which I sent to La Crosse, Wis., for and called the Governor Rusk. I wish I had the same kind to try here. I would also like to try the Early Ohio or the Michigan.

About those wireworms: Ashes did not kill them; they were there just the same, but the ashes gave me a smoother potato, and the worms did not bother them as much. I put a shovelful on the hill when the potatoes were about a foot high, and then hilled them up, covering the ashes. I shall try freezing them this season, and I believe that will be a specific. Chickens would get away with many of them. I notice the robins in early spring are always following me when I grub the ground, always picking and digging for them, and these welcome friends are always here in the early spring, and they remind one of the States and of civilization.

I shall have quite a lot of seeds from radishes, turnips, and ruta-bagas, which will mature this season. They are about all ripe now.

Some one suggested in your report that a man should be hired to travel about and teach the natives to farm. I believe that would be a good plan. I have quite frequent visits from natives, and all seem to take an interest in what I am doing. They wonder at the growth and ask the names of different vegetables. They like to eat them, too, and I have given them quite a few. I tell them also to come in the spring and get some seeds to plant themselves, so if you could send me an extra amount of different kinds, but especially of turnips, I shall divide with them. Potatoes seem to be their favorite vegetable. One of them asked me if I was going to raise oranges. I will try peanuts next spring if I can get a few that are fresh.

I had a small package of corn sent me; received too late for planting this year. One must plant early, so that the hot weather in June can get its work in on corn. I may not mature corn, but I am most certain I can raise roasting ears.

If you can send me a few cherries and other fruit trees, I will try them in my warm ground.

*John A. Clinton, Rampart.*—Inclosed find a few heads of Mansbury barley, the seed of which you sent me two years ago, and one head of oats. When received, the paper of oats was eaten by mice, so I could not see the name. The barley I sowed May 26, 1903. It came up fine with a good stand and grew fast; headed out by July 10. I sowed it in a garden patch about 30 by 30 feet of good land. It had been tilled for three years. I built a good fence around it. I felt proud of my barley patch, when about that time the mice living in the adjoining wild land got a taste for the tender, sweet stems, and went for it like a crew of loggers slashing into a choice patch of timber. I felt sore about it. But for the fact of our keeping some 20-odd wolfish, ever-hungry native dogs, I would have gone in for some wholesale poisoning of mice. The few plants the mice spared me are all ripe now. The oats are turning yellow. We have had no frost yet (September 8, 1903).

This summer has been an average one. Spring came about ten days to two weeks later than last year. June dry and hot. July rather wet and cool.

All of the hardy vegetables did well. Of lettuce, the Early Curly and Prize Head did the best. The Boston Market went to seed before it made good heads. The cauliflower is very fine; Dwarf Erfurt, largest 8 inches in diameter. Beets, Egyptian did the best. Cabbage, Early Wakefield; some weigh 5 pounds and still growing. Ruta-bagas, White Fleshed; most advanced; do better when transplanted; make a cleaner root than when seeded in place. Turnips do about as well as a native weed; I consider them a sure crop any year, especially the Purple-Top Strap Leaf; the White Milan is more delicate, but does not keep well in winter. Peas did well. Early Alaska comes in about two weeks ahead of Abundance. Parsley and carrots did not do well, but may grow yet. Cress has done very well. I had never sowed any before. It was a surprise. I sowed it in a shady place; kept it well watered. We cut it about every ten days. It came in before the lettuce. It is all right. Parsley and onions did not come up well.

The flowers all came up well. As I write this I see in front of the window, unhurt by frost, sweet peas, mignonette, nasturtiums, poppies, petunias, marigolds, and some others. They are good to look upon.

The weather is fine for this time of the year, and the garden truck is still growing. I would like to try some of the hulless barley. The grass seed you sent I sowed as soon as the snow went off in some favored spots where the fire had destroyed the moss. Have not had time to look up results.

*Rev. G. S. Clevenger, Copper Center.*—Yours of November received, and I thank you for the grain and seeds which you think you can furnish us. I keep constantly at the Indians about planting gardens. I think we can make a start next year with them in gardening.

The weather up to this time (December 7, 1903) has been fine. One can work outside every day. We have been getting our hay down from the lake, about 5 miles from Copper Center. We bale it and then haul it down on sleds. We will have about 200 bales of, say, 75 pounds each. We were told that the swamp grass was no good. My cow is in very fine condition on it with very little feed besides. I do not feed her quite 2 quarts of meal a day. She is really fat.

Copper Center is not nearly so dreary as Skagway or Valdez. We have so much sunshine that the days do not seem so short. We think it is as fine a climate as we have ever lived in, thus far much preferable to that of South Dakota. Our greatest difficulty is isolation and mails so far apart.

*C. M. Frazier, Eagle.*—Your letter of January 29 duly received. I am mining in the upper Tanana. I spent last season in that country.

I was raised on a farm in Iowa, and will always take an interest in agriculture. I read your report for 1902 with great interest, and I will note some facts concerning the Tanana Valley.

Within 8 miles of the Tanana Crossing 25 tons of redtop hay was cut on less than 3 acres in a very few days last July (1903), and hundreds of acres just as good were untouched. Dense forests of spruce, birch, and cottonwood of good size extend to the headwaters. The soil is varied. Where the cottonwood grows it is gravel after you get down a little, muck where the grass is plentiful, and vegetable mold where the spruce and birch stand. The valley is from 15 to 50 miles wide and 200 miles long above the crossing; not more than 2 feet of snow in winter, and very little wind. From personal observation and from men and Indians living there I obtained these facts. The trail, Eagle to Valdez, follows the cottonwood ridges.

*Rev. John B. Driggs, Point Hope.*—My experiments in raising vegetables at Point Hope have not proved a success. I am on my way south to spend a winter in the States, and on my return north next year (1905) hope to continue my experiments. I will say that the past four or five years have been very unfavorable.

*Frank E. Howard, U. S. Commissioner, Coldfoot.*—I distributed the seed, and the consequences are that during 1904 there are a number of flourishing gardens in Coldfoot and on the creeks. My own garden is growing nicely, notwithstanding the cold nights during June. I have cabbage just beginning to head, radishes for the table, turnips for greens, peas over a foot high, and will have lettuce in a day or two. I have potatoes over a foot high with blossoms just started. Beets are 2 inches high, kale 10 inches; parsnips and carrots are growing slowly, but rather doubtful.

I will continue the weather report as long as I remain in the office, and will send you a full report of the crops in the fall.

I request that you send me another lot of seeds as early as it would be convenient for you to mail them, for if they do not get here before the close of navigation this fall they will not be in time for planting next spring. The principal seeds should be turnips, ruta-bagas, lettuce, radishes, cabbage, and peas, and also some flowers.

Several Indian families here have expressed their willingness to plant patches of turnips and ruta-bagas next spring if they can get the seeds and receive a few instructions in gardening. I will undertake the latter if you will supply them with the former. I have given them several messes of greens, and I believe with a little encouragement they would enter into gardening with enthusiasm. The Indians here are quite different from those on the coast of Alaska. They are strictly sober, virtuous, and industrious.

## SOIL TEMPERATURES.

I submit herewith daily records of the soil temperatures at the three stations, Sitka, Kenai, and Copper Center. The readings are from two thermometers, one of which has the bulb buried in the soil 6 inches deep, and the other has it buried 2 feet deep. At Sitka and Copper Center we have in addition a radiation thermometer, placed near the soil thermometers, and suspended 6 inches above the surface of the ground. This is for the purpose of ascertaining the lowest temperature during each 24 hours near the surface of the ground. The radiation thermometer is practically only a minimum thermometer, which records the lowest figure to which the temperature falls. We find that it frequently records temperatures from 2° to 4° lower than the regular Weather Bureau minimum thermometer, which is placed in a shelter box about 4 feet from the ground. Being unprotected the radiation thermometer is more sensitive to slight variations in temperature. Sometimes it indicates a drop below the frost line, when the sheltered instruments show a considerably higher temperature. These slight drops of short duration seldom kill any but the tenderest plants, but they nevertheless have their influence in retarding growth, and to a certain extent on the radiation from the soil.

It is worth while for those interested in the subject to study the soil temperatures as here recorded. It will be noticed that the 6-inch thermometer shows considerable fluctuation from day to day, while the 24-inch thermometer shows scarcely any daily fluctuation. The fluctuations in the 6-inch thermometer are due to the alternations of rain and sunshine. But the one important fact is that unless the 6-inch thermometer maintains an average above 52° from the middle of June to the middle of August, grain crops can not prosper. If this average is maintained hardy plants, like oats and barley, will develop, but their maturing is still dependent on the length of time frosts hold off.

*Soil temperatures.*

SITKA EXPERIMENT STATION.

| Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904. | °*F.* | °*F.* | °*F.* | 1904. | °*F.* | °*F.* | °*F.* | 1904. | °*F.* | °*F.* | °*F.* |
| May 1 | -------- | -------- | -------- | June 25 | 48.5 | 45.0 | 46.0 | Aug. 19 | 53.0 | 51.0 | 48.0 |
| May 2 | 39.0 | 35.0 | -------- | June 26 | 48.0 | 45.5 | 43.0 | Aug. 20 | 52.0 | 50.5 | 46.0 |
| May 3 | 37.5 | 35.0 | 35.0 | June 27 | 48.5 | 45.5 | 45.0 | Aug. 21 | 52.0 | 50.5 | 47.0 |
| May 4 | 35.0 | 36.0 | 35.5 | June 28 | 48.5 | 45.5 | 48.0 | Aug. 22 | 53.0 | 50.5 | 47.0 |
| May 5 | 35.5 | 36.5 | 33.0 | June 29 | 48.0 | 45.5 | 42.0 | Aug. 23 | 53.0 | 50.5 | 47.0 |
| May 6 | 36.0 | 36.0 | 37.0 | June 30 | 48.0 | 45.5 | 38.0 | Aug. 24 | 53.5 | 50.5 | 48.0 |
| May 7 | 40.5 | 36.0 | 44.0 | July 1 | 48.0 | 46.0 | 41.0 | Aug. 25 | 53.5 | 50.5 | 47.0 |
| May 8 | 40.5 | 36.0 | 41.0 | July 2 | 48.0 | 46.0 | 43.0 | Aug. 26 | 53.0 | 50.5 | 42.0 |
| May 9 | 40.0 | 37.0 | 33.0 | July 3 | 48.0 | 46.0 | 38.0 | Aug. 27 | 52.0 | 50.5 | 35.0 |
| May 10 | 40.5 | 37.0 | 27.0 | July 4 | 48.0 | 46.0 | 42.0 | Aug. 28 | 52.0 | 50.5 | 38.0 |
| May 11 | 40.5 | 37.0 | 30.0 | July 5 | 48.0 | 46.5 | 38.0 | Aug. 29 | 52.5 | 50.5 | 44.0 |
| May 12 | 41.5 | 37.5 | 38.0 | July 6 | 48.0 | 46.5 | 36.0 | Aug. 30 | 53.5 | 50.5 | 45.0 |
| May 13 | 42.5 | 37.5 | 40.0 | July 7 | 48.0 | 46.5 | 33.0 | Aug. 31 | 54.0 | 50.5 | 44.0 |
| May 14 | 43.0 | 38.0 | 38.0 | July 8 | 49.0 | 46.5 | 45.0 | Sept. 1 | 54.0 | 50.5 | 41.0 |
| May 15 | 43.0 | 38.5 | 36.0 | July 9 | 49.0 | 46.5 | 43.0 | Sept. 2 | 53.0 | 50.5 | 39.0 |
| May 16 | 42.5 | 38.5 | 36.0 | July 10 | 49.0 | 46.5 | 40.0 | Sept. 3 | 53.0 | 51.0 | 48.0 |
| May 17 | 43.5 | 39.0 | 37.0 | July 11 | 49.0 | 46.5 | 39.0 | Sept. 4 | 54.0 | 51.0 | 50.0 |
| May 18 | 43.0 | 39.5 | 35.0 | July 12 | 49.5 | 46.5 | 41.0 | Sept. 5 | 54.0 | 51.0 | 48.0 |
| May 19 | 42.5 | 39.5 | 41.0 | July 13 | 49.5 | 47.0 | 35.0 | Sept. 6 | 53.0 | 51.0 | 47.0 |
| May 20 | 42.5 | 39.5 | 39.0 | July 14 | 49.5 | 47.0 | 45.0 | Sept. 7 | 51.0 | 51.0 | 43.0 |
| May 21 | 42.5 | 40.0 | 35.0 | July 15 | 49.5 | 47.0 | 43.0 | Sept. 8 | 50.0 | 51.0 | 38.0 |
| May 22 | 43.0 | 40.5 | 35.0 | July 16 | 50.0 | 47.0 | 43.0 | Sept. 9 | 51.0 | 51.0 | 44.0 |
| May 23 | 43.0 | 40.5 | 36.0 | July 17 | 50.0 | 47.0 | 39.0 | Sept. 10 | 50.5 | 50.5 | 46.0 |
| May 24 | 43.0 | 40.5 | 30.0 | July 18 | 51.5 | 47.0 | 47.0 | Sept. 11 | 51.5 | 50.5 | 44.0 |
| May 25 | 43.5 | 40.5 | 33.0 | July 19 | 51.5 | 47.5 | 45.0 | Sept. 12 | 51.5 | 50.5 | 46.0 |
| May 26 | 43.5 | 41.0 | 40.0 | July 20 | 51.5 | 47.5 | 45.0 | Sept. 13 | 52.0 | 50.5 | 42.0 |
| May 27 | 44.0 | 41.0 | 37.0 | July 21 | 51.0 | 47.5 | 39.0 | Sept. 14 | 51.5 | 50.5 | -------- |
| May 28 | 45.0 | 41.0 | 38.0 | July 22 | 51.5 | 47.5 | 45.0 | Sept. 15 | 51.5 | 50.5 | 46.0 |
| May 29 | 45.0 | 41.5 | 38.0 | July 23 | 51.0 | 48.0 | 43.0 | Sept. 16 | 51.5 | 50.5 | 44.0 |
| May 30 | 45.0 | 41.5 | 40.0 | July 24 | 51.0 | 48.0 | 44.0 | Sept. 17 | 50.5 | 50.5 | 45.0 |
| May 31 | 46.0 | 42.0 | 40.0 | July 25 | 51.0 | 48.0 | 47.0 | Sept. 18 | 49.5 | 50.5 | 35.0 |
| June 1 | 47.5 | 42.0 | 43.0 | July 26 | 51.5 | 48.0 | 46.0 | Sept. 19 | 48.5 | 50.0 | 36.0 |
| June 2 | 47.5 | 42.0 | 43.0 | July 27 | 53.0 | 48.5 | 51.0 | Sept. 20 | 45.5 | 50.0 | 38.0 |
| June 3 | 47.5 | 42.5 | 35.0 | July 28 | 53.0 | 48.5 | 48.0 | Sept. 21 | 46.5 | 49.5 | 40.0 |
| June 4 | 47.5 | 43.0 | 44.0 | July 29 | 52.5 | 49.0 | -------- | Sept. 22 | 46.0 | 49.5 | 31.0 |
| June 5 | 47.5 | 43.0 | 38.0 | July 30 | 52.5 | 49.0 | 48.0 | Sept. 23 | 46.0 | 49.0 | 30.0 |
| June 6 | 46.0 | 43.5 | 30.0 | July 31 | 53.0 | 49.5 | 48.0 | Sept. 24 | 47.0 | 49.0 | 31.0 |
| June 7 | 46.5 | 43.5 | 34.0 | Aug. 1 | 52.0 | 49.5 | 46.0 | Sept. 25 | 49.5 | 48.5 | 47.0 |
| June 8 | 47.0 | 43.5 | 40.0 | Aug. 2 | 51.5 | 49.5 | 46.0 | Sept. 26 | 49.5 | 48.5 | 45.0 |
| June 9 | 48.0 | 43.5 | 41.0 | Aug. 3 | 51.0 | 49.5 | 45.0 | Sept. 27 | 49.5 | 48.5 | 45.0 |
| June 10 | 48.0 | 44.0 | 43.0 | Aug. 4 | 52.5 | 49.5 | 45.5 | Sept. 28 | 49.0 | 48.5 | 44.0 |
| June 11 | 48.0 | 44.0 | 41.0 | Aug. 5 | 52.0 | 49.5 | 37.5 | Sept. 29 | -------- | -------- | -------- |
| June 12 | 48.0 | 44.0 | 35.0 | Aug. 6 | 52.5 | 49.5 | 38.0 | Sept. 30 | -------- | -------- | -------- |
| June 13 | 47.0 | 44.0 | 41.0 | Aug. 7 | 54.0 | 49.5 | 41.0 | Oct. 4 | 44.5 | 48.5 | 29.0 |
| June 14 | 47.0 | 44.5 | 42.0 | Aug. 8 | 54.5 | 49.5 | 45.0 | Oct. 5 | 44.0 | 48.0 | 29.0 |
| June 15 | 47.0 | 44.5 | 42.0 | Aug. 9 | 54.0 | 50.0 | 49.0 | Oct. 6 | 43.0 | 48.0 | 27.0 |
| June 16 | 47.0 | 44.5 | 40.0 | Aug. 10 | 53.5 | 50.0 | 36.0 | Oct. 7 | 42.5 | 47.5 | 26.0 |
| June 17 | 46.5 | 44.5 | 40.0 | Aug. 11 | 54.0 | 50.0 | 47.0 | Oct. 8 | 42.0 | 47.0 | 26.0 |
| June 18 | 46.5 | 44.5 | 41.0 | Aug. 12 | 54.0 | 50.0 | 47.0 | Oct. 9 | 44.0 | 47.0 | 39.0 |
| June 19 | 47.0 | 44.5 | 42.0 | Aug. 13 | 54.0 | 51.0 | 50.0 | Oct. 10 | 46.0 | 46.5 | 49.0 |
| June 20 | 47.0 | 44.5 | 42.0 | Aug. 14 | 54.0 | 51.0 | 49.0 | Oct. 11 | 46.0 | 46.5 | 42.0 |
| June 21 | 47.5 | 45.0 | 32.0 | Aug. 15 | 53.0 | 51.0 | 36.0 | Oct. 12 | 46.5 | 46.5 | 40.0 |
| June 22 | 47.5 | 45.0 | 37.0 | Aug. 16 | 53.0 | 51.0 | 42.0 | Oct. 13 | 46.5 | 46.5 | 41.0 |
| June 23 | 48.5 | 45.0 | 43.0 | Aug. 17 | 54.0 | 50.5 | 41.0 | Oct. 14 | 46.5 | 46.5 | 41.0 |
| June 24 | 48.5 | 45.0 | 45.0 | Aug. 18 | 53.0 | 51.0 | 46.0 | Oct. 15 | 45.5 | 46.5 | 39.0 |

*Soil temperatures*—Continued.

KENAI EXPERIMENT STATION.

| Day. | 6-inch thermometer. | 24-inch thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. |
|---|---|---|---|---|---|---|---|---|
| 1904. | ° *F.* | ° *F.* | 1904. | ° *F.* | ° *F.* | 1904. | ° *F.* | ° *F.* |
| May 10 | 36.0 | ........... | June 27 | 48.0 | 40.5 | Aug. 14 | 52.0 | 46.5 |
| May 11 | 38.0 | ........... | June 28 | 51.0 | 40.5 | Aug. 15 | 52.0 | 46.5 |
| May 12 | 36.5 | ........... | June 29 | 52.5 | 40.5 | Aug. 16 | 53.0 | 46.5 |
| May 13 | 38.5 | ........... | June 30 | 52.0 | 41.0 | Aug. 17 | 51.5 | 46.5 |
| May 14 | 40.0 | ........... | July 1 | 49.5 | 41.0 | Aug. 18 | 52.0 | 46.5 |
| May 15 | 38.5 | ........... | July 2 | 48.5 | 41.5 | Aug. 19 | 52.0 | 47.0 |
| May 16 | 38.5 | ........... | July 3 | 51.0 | 41.5 | Aug. 20 | 52.0 | 47.0 |
| May 17 | 39.0 | ........... | July 4 | 52.5 | 41.0 | Aug. 21 | 49.5 | 46.5 |
| May 18 | 39.0 | ........... | July 5 | 52.5 | 41.5 | Aug. 22 | 50.5 | 46.5 |
| May 19 | 38.0 | ........... | July 6 | 51.0 | 41.5 | Aug. 23 | 50.5 | 46.5 |
| May 20 | 41.5 | ........... | July 7 | 49.0 | 41.5 | Aug. 24 | 52.0 | 46.5 |
| May 21 | 41.5 | ........... | July 8 | 50.5 | 41.5 | Aug. 25 | 51.5 | 46.6 |
| May 22 | 42.0 | ........... | July 9 | 50.0 | 41.6 | Aug. 26 | 49.5 | 46.5 |
| May 23 | 41.0 | ........... | July 10 | 51.5 | 42.0 | Aug. 27 | 49.0 | 46.5 |
| May 24 | 41.5 | ........... | July 11 | 53.5 | 42.0 | Aug. 28 | 50.0 | 46.0 |
| May 25 | 41.5 | ........... | July 12 | 54.0 | 42.0 | Aug. 29 | 52.5 | 46.0 |
| May 26 | 44.0 | ........... | July 13 | 52.0 | 42.5 | Aug. 30 | 53.5 | 46.0 |
| May 27 | 45.0 | ........... | July 14 | 54.0 | 42.5 | Aug. 31 | 51.5 | 46.5 |
| May 28 | 45.0 | ........... | July 15 | 55.0 | 43.0 | Sept. 1 | 54.0 | 46.5 |
| May 29 | 42.5 | ........... | July 16 | 56.0 | 43.0 | Sept. 2 | 54.0 | 46.5 |
| May 30 | 42.5 | ........... | July 17 | 55.5 | 43.5 | Sept. 3 | 52.5 | 46.5 |
| May 31 | 42.5 | ........... | July 18 | 55.5 | 43.5 | Sept. 4 | 53.0 | 46.5 |
| June 1 | 45.0 | 33.5 | July 19 | 56.5 | 44.0 | Sept. 5 | 52.5 | 46.5 |
| June 2 | 45.5 | 34.0 | July 20 | 55.0 | 44.0 | Sept. 6 | 48.5 | 46.5 |
| June 3 | 46.0 | 34.5 | July 21 | 56.5 | 44.5 | Sept. 7 | 48.0 | 46.5 |
| June 4 | 47.0 | 35.0 | July 22 | 53.5 | 44.5 | Sept. 8 | 48.0 | 46.5 |
| June 5 | 47.5 | 35.5 | July 23 | 53.5 | 45.0 | Sept. 9 | 47.5 | 45.5 |
| June 6 | 48.0 | 36.0 | July 24 | 51.5 | 45.0 | Sept. 10 | 48.0 | 45.0 |
| June 7 | 46.0 | 36.5 | July 25 | 52.5 | 45.0 | Sept. 11 | 45.5 | 45.0 |
| June 8 | 48.0 | 36.5 | July 26 | 53.5 | 44.5 | Sept. 12 | 48.0 | 45.0 |
| June 9 | 49.5 | 36.5 | July 27 | 52.0 | 44.5 | Sept. 13 | 46.0 | 45.0 |
| June 10 | 50.5 | 37.0 | July 28 | 52.0 | 44.5 | Sept. 14 | 46.0 | 45.0 |
| June 11 | 50.5 | 37.5 | July 29 | 52.0 | 44.5 | Sept. 15 | 47.0 | 45.0 |
| June 12 | 50.5 | 38.0 | July 30 | 51.0 | 44.5 | Sept. 16 | 48.0 | 45.0 |
| June 13 | 51.5 | 38.5 | July 31 | 53.0 | 45.0 | Sept. 17 | 45.0 | 44.5 |
| June 14 | 52.5 | 39.0 | Aug. 1 | 51.5 | 45.0 | Sept. 18 | 43.5 | 44.5 |
| June 15 | 52.5 | 39.0 | Aug. 2 | 51.0 | 45.0 | Sept. 19 | 43.5 | 44.0 |
| June 16 | 49.0 | 39.5 | Aug. 3 | 52.0 | 45.0 | Sept. 20 | 39.5 | 43.5 |
| June 17 | 50.0 | 40.0 | Aug. 4 | 52.0 | 45.0 | Sept. 21 | 39.5 | 42.5 |
| June 18 | 48.5 | 40.0 | Aug. 5 | 52.5 | 45.0 | Sept. 22 | 42.0 | 42.0 |
| June 19 | 48.0 | 40.0 | Aug. 6 | 53.5 | 45.5 | Sept. 23 | 44.5 | 41.5 |
| June 20 | 52.5 | 40.0 | Aug. 7 | 56.0 | 45.5 | Sept. 24 | 46.0 | 42.0 |
| June 21 | 49.0 | 40.5 | Aug. 8 | 57.0 | 46.0 | Sept. 25 | 45.5 | 42.5 |
| June 22 | 49.0 | 40.5 | Aug. 9 | 57.0 | 46.0 | Sept. 26 | 45.5 | 42.5 |
| June 23 | 48.0 | 50.5 | Aug. 10 | 57.5 | 46.5 | Sept. 27 | 45.0 | 43.0 |
| June 24 | 49.0 | 40.5 | Aug. 11 | 52.5 | 46.5 | Sept. 28 | 45.0 | 43.0 |
| June 25 | 49.0 | 40.5 | Aug. 12 | 52.0 | 47.0 | Sept. 29 | 42.0 | 43.0 |
| June 26 | 47.0 | 40.5 | Aug. 13 | 51.0 | 47.0 | Sept. 30 | 41.0 | 42.5 |

*Soil temperatures*—Continued.

COPPER CENTER EXPERIMENT STATION.

| Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. | Day. | 6-inch thermometer. | 24-inch thermometer. | Radiation thermometer. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1904. | ° *F.* | ° *F.* | ° *F.* | 1904. | ° *F.* | ° *F.* | ° *F.* | 1904. | ° *F.* | ° *F.* | ° *F.* |
| May 6 | 35.0 | 31.0 | 19.0 | June 25 | 50.5 | 42.0 | 37.0 | Aug. 14 | 48.0 | 45.5 | 19.0 |
| May 7 | 35.0 | 31.0 | 28.0 | June 26 | 50.0 | 42.0 | 36.0 | Aug. 15 | 48.0 | 45.0 | 17.0 |
| May 8 | 35.0 | 31.0 | 20.0 | June 27 | 48.5 | 42.0 | 34.0 | Aug. 16 | 48.5 | 44.5 | 16.0 |
| May 9 | 36.0 | 31.0 | 15.0 | June 28 | 49.5 | 42.0 | 39.0 | Aug. 17 | 48.5 | 44.0 | 12.0 |
| May 10 | 37.0 | 31.0 | 22.0 | June 29 | 52.0 | 42.0 | 37.0 | Aug. 18 | 47.5 | 44.0 | 17.0 |
| May 11 | 38.0 | 31.0 | 24.0 | June 30 | 47.5 | 42.5 | 33.0 | Aug. 19 | 48.0 | 44.0 | 34.0 |
| May 12 | 38.0 | 31.0 | 22.0 | July 1 | 49.0 | 42.5 | 22.0 | Aug. 20 | 48.0 | 44.0 | 33.0 |
| May 13 | 40.0 | 31.0 | 28.0 | July 2 | 50.0 | 42.5 | 30.0 | Aug. 21 | 48.5 | 44.0 | 30.0 |
| May 14 | 38.0 | 31.5 | 25.0 | July 3 | 48.0 | 42.5 | 34.0 | Aug. 22 | 50.0 | 44.0 | 35.0 |
| May 15 | 38.0 | 31.5 | 21.0 | July 4 | 47.0 | 42.5 | 25.0 | Aug. 23 | 50.0 | 44.0 | 33.0 |
| May 16 | 38.0 | 31.5 | 30.0 | July 5 | 47.5 | 42.0 | 32.0 | Aug. 24 | 50.0 | 44.0 | 32.0 |
| May 17 | 38.0 | 31.5 | 18.0 | July 6 | 49.0 | 42.0 | 26.0 | Aug. 25 | 48.0 | 44.0 | 25.0 |
| May 18 | 38.5 | 32.0 | 24.0 | July 7 | 50.0 | 42.0 | 32.0 | Aug. 26 | 44.0 | 43.5 | 12.0 |
| May 19 | 39.0 | 32.0 | 27.0 | July 8 | 49.0 | 42.5 | 33.0 | Aug. 27 | 45.0 | 43.5 | 27.0 |
| May 20 | 39.0 | 32.0 | 23.0 | July 9 | 49.0 | 43.5 | 33.0 | Aug. 28 | 44.0 | 43.5 | 27.0 |
| May 21 | 40.0 | 32.0 | 31.0 | July 10 | 49.0 | 42.5 | 32.0 | Aug. 29 | 44.5 | 43.5 | 31.0 |
| May 22 | 40.0 | 32.0 | 23.0 | July 11 | 52.0 | 42.5 | 42.0 | Aug. 30 | 46.0 | 42.0 | 32.0 |
| May 23 | 42.0 | 32.0 | 19.0 | July 12 | 50.0 | 42.5 | 29.0 | Aug. 31 | 46.5 | 42.0 | 31.0 |
| May 24 | 42.5 | 32.0 | 32.0 | July 13 | 51.0 | 43.0 | 37.0 | Sept. 1 | 46.5 | 42.0 | 21.0 |
| May 25 | 42.5 | 32.0 | 19.0 | July 14 | 52.0 | 43.0 | 35.0 | Sept. 2 | 45.0 | 42.0 | 11.0 |
| May 26 | 42.5 | 32.0 | 24.0 | July 15 | 52.5 | 43.5 | 25.0 | Sept. 3 | 45.0 | 41.5 | 13.0 |
| May 27 | 42.5 | 32.0 | 23.0 | July 16 | 52.0 | 43.5 | 24.0 | Sept. 4 | 45.0 | 41.5 | 15.0 |
| May 28 | 42.5 | 32.5 | 24.0 | July 17 | 54.0 | 44.5 | 36.0 | Sept. 5 | 43.0 | 41.5 | 10.0 |
| May 29 | 42.5 | 33.0 | 25.0 | July 18 | 52.5 | 45.0 | 23.0 | Sept. 6 | 40.0 | 41.0 | 11.0 |
| May 30 | 42.5 | 33.0 | 33.0 | July 19 | 55.5 | 45.0 | 38.0 | Sept. 7 | 39.0 | 40.5 | 4.0 |
| May 31 | 43.5 | 33.5 | 25.0 | July 20 | 49.0 | 45.0 | 23.0 | Sept. 8 | 38.0 | 40.0 | 2.0 |
| June 1 | 47.5 | 33.5 | 28.0 | July 21 | 52.5 | 45.0 | 35.0 | Sept. 9 | 38.0 | 40.0 | 14.0 |
| June 2 | 46.0 | 34.5 | 24.0 | July 22 | 49.5 | 44.5 | 28.0 | Sept. 10 | 40.0 | 40.0 | 26.0 |
| June 3 | 48.5 | 35.0 | 30.0 | July 23 | 50.0 | 44.5 | 34.0 | Sept. 11 | 40.0 | 39.0 | 23.0 |
| June 4 | 49.0 | 35.5 | 34.0 | July 24 | 48.0 | 44.5 | 34.0 | Sept. 12 | 41.0 | 38.5 | 28.0 |
| June 5 | 49.0 | 35.0 | 32.0 | July 25 | 50.0 | 44.0 | 22.0 | Sept. 13 | 42.5 | 38.5 | 28.0 |
| June 6 | 48.0 | 36.0 | 32.0 | July 26 | 51.0 | 44.0 | 21.0 | Sept. 14 | 42.5 | 39.0 | 25.0 |
| June 7 | 47.0 | 36.5 | 31.0 | July 27 | 53.0 | 44.5 | 22.0 | Sept. 15 | 42.5 | 39.0 | 26.0 |
| June 8 | 46.5 | 36.5 | 33.0 | July 28 | 51.0 | 44.5 | 32.0 | Sept. 16 | 38.0 | 39.0 | 10.0 |
| June 9 | 47.0 | 37.5 | 26.0 | July 29 | 50.0 | 44.5 | 32.0 | Sept. 17 | 38.0 | 39.0 | 13.0 |
| June 10 | 48.0 | 37.5 | 36.0 | July 30 | 50.0 | 44.5 | 31.0 | Sept. 18 | 38.0 | 39.0 | 11.0 |
| June 11 | 49.0 | 38.0 | 37.0 | July 31 | 48.5 | 44.5 | 30.0 | Sept. 19 | 34.5 | 37.5 | −8.0 |
| June 12 | 47.5 | 39.0 | 29.0 | Aug. 1 | 50.0 | 44.5 | 35.0 | Sept. 20 | 33.0 | 37.0 | −8.0 |
| June 13 | 48.0 | 39.0 | 26.0 | Aug. 2 | 50.5 | 44.0 | 36.0 | Sept. 21 | 33.5 | 36.5 | 5.0 |
| June 14 | 50.0 | 39.5 | 34.0 | Aug. 3 | 49.0 | 44.0 | 34.0 | Sept. 22 | 32.0 | 35.0 | 7.0 |
| June 15 | 49.0 | 40.0 | 30.0 | Aug. 4 | 47.5 | 44.0 | 18.0 | Sept. 23 | 37.0 | 37.0 | 19.0 |
| June 16 | 48.0 | 40.0 | 35.0 | Aug. 5 | 47.5 | 44.0 | 17.0 | Sept. 24 | 37.0 | 37.0 | 19.0 |
| June 17 | 45.5 | 40.5 | 35.0 | Aug. 6 | 50.0 | 43.5 | 28.0 | Sept. 25 | 38.0 | 36.5 | 31.0 |
| June 18 | 46.5 | 40.5 | 28.0 | Aug. 7 | 51.0 | 43.5 | 25.0 | Sept. 26 | 39.0 | 37.0 | 25.0 |
| June 19 | 47.0 | 40.5 | 29.0 | Aug. 8 | 54.0 | 44.0 | 22.0 | Sept. 27 | 40.5 | 37.5 | 38.0 |
| June 20 | 50.0 | 40.5 | 36.0 | Aug. 9 | 55.0 | 44.5 | 19.0 | Sept. 28 | 37.5 | 38.0 | 15.0 |
| June 21 | 49.0 | 41.0 | 33.0 | Aug. 10 | 55.5 | 45.0 | 25.0 | Sept. 29 | 37.5 | 38.0 | 20.0 |
| June 22 | 49.0 | 41.0 | 30.0 | Aug. 11 | 55.5 | 45.5 | 41.0 | Sept. 30 | 35.5 | 38.0 | 3.0 |
| June 23 | 51.0 | 41.5 | 34.0 | Aug. 12 | 51.5 | 45.5 | 36.0 | | | | |
| June 24 | 50.5 | 42.0 | 33.0 | Aug. 13 | 50.5 | 45.5 | 34.0 | | | | |

## METEOROLOGICAL REPORTS.

As in former years, the writer has had general supervision of the voluntary weather observers of the Weather Bureau in Alaska, and submits herewith more or less complete reports from 28 stations. Their records are made daily, but since these daily records would occupy too much space in this report they have been condensed so as to give the result for each month. They show the maximum and minimum temperatures which occurred during the month; but the most important column is the one showing the daily mean, it being the correct average temperature for the entire month.

Space does not permit comment on these reports now, but at an early date a bulletin should be published on the climate of Alaska, as it may be presented from the accumulated reports during the past six years.

### *Meteorological observations.*

SITKA. C. C. Georgeson, observer.

| Month. | Temperature. | | | Total. precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| **1903.** | ° *F.* | ° *F.* | ° *F.* | *Inches.* | | | | |
| October | 59 | 30 | 45.36 | 14.82 | 3 | 7 | 21 | 26 |
| November | 54 | 16 | 36.35 | 6.5 | .......... | 13 | 17 | 15 |
| December | 49 | 25 | 40.11 | 14.97 | .......... | 9 | 22 | 22 |
| **1904.** | | | | | | | | |
| January | 44 | 5 | 30.22 | 9.76 | 5 | 4 | 22 | 14 |
| February | 43 | 10 | 25.5 | 23.01 | 18 | 6 | 5 | 1 |
| March | 51 | 7 | 32.17 | 3.04 | 15 | 10 | 6 | 6 |
| April | 56 | 59 | 40.73 | 3.39 | .......... | 20 | 10 | 19 |
| May | 57 | 33 | 44.4 | 3.80 | .......... | 10 | 21 | 21 |
| June | 56 | 32 | 47.06 | 3.22 | 4 | 5 | 21 | 22 |
| July | 62 | 34 | 55.8 | 5.95 | .......... | 12 | 19 | 26 |
| August | 70 | 40 | 52.9 | 4.14 | 6 | 14 | 11 | .......... |
| September | 71 | 36 | 50.51 | 13.27 | 5 | 9 | 16 | 23 |

KENAI. P. H. Ross, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1903.** | | | | | | | | |
| September | 62 | 20 | 45.5 | 2.72 | 12 | 8 | 10 | 12 |
| October | 59 | − 2 | 31.14 | .77 | 6 | 8 | 17 | 8 |
| November | 34 | −27 | 17.56 | .78 | 9 | 2 | 19 | 6 |
| December | 40 | −10 | 20.03 | .18 | 7 | 3 | 21 | 6 |
| **1904.** | | | | | | | | |
| January | 35 | −34 | 8.7 | .46 | 14 | 4 | 13 | 7 |
| February | 31 | −27 | 5.18 | .29 | 23 | 2 | 4 | 2 |
| March | 42 | .......... | .......... | .02 | 24 | 5 | 2 | 1 |
| April | 55 | .......... | .......... | .34 | 5 | 12 | 13 | 2 |
| May | 61 | 24 | 44.14 | .......... | 22 | 5 | 4 | .......... |
| June | 65 | 29 | 48.3 | .87 | 14 | 6 | 10 | 9 |
| July | 65 | 27 | 49.55 | 2.44 | 13 | 6 | 12 | 13 |
| August | 73 | 25 | 50.7 | 3.5 | 8 | 9 | 14 | 14 |
| September | 75 | 11 | 44.64 | 4.01 | 19 | 2 | 9 | 10 |

COPPER CENTER. J. W. Neal, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1903.** | | | | | | | | |
| October | 52 | −11 | 24.75 | 1.71 | 6 | 9 | 16 | 7 |
| November | 35 | −37 | − 3.64 | .2 | 17 | 11 | 2 | 8 |
| December | 39 | −19 | 6.3 | .8 | 2 | 9 | 19 | .......... |
| **1904.** | | | | | | | | |
| January | 42 | −59 | −12.3 | .31 | 21 | 3 | 5 | 2 |
| February | 25 | −47 | −10.7 | .22 | 17 | 3 | 8 | 1 |
| March | 47 | −42 | 3.6 | .......... | 18 | .......... | 13 | .......... |
| April | 58 | 8 | 34 | .24 | 10 | 10 | 10 | 4 |
| May | 75 | 21 | 44.59 | .82 | .......... | 11 | 20 | 12 |
| June | 76 | 32 | 52.03 | 1.11 | .......... | 13 | 17 | 13 |
| July | 82 | 32 | 52.67 | 1.8 | 5 | 11 | 14 | 13 |
| August | 87 | 24 | 52.22 | 2.09 | 6 | 6 | 18 | 12 |
| September | 67 | 6 | 40.5 | .73 | 16 | 5 | 9 | 7 |

## *Meteorological observations*—Continued.

### LORING. Fred Patching, observer.

| Month. | Temperature. | | | Total precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| 1903. | °*F.* | °*F.* | °*F.* | *Inches.* | | | | |
| November | 54 | 8 | 34.33 | 16.7 | 6 | ---------- | 24 | 19 |
| December | 53 | 22 | 39 | 21.5 | 2 | ---------- | 29 | 25 |
| 1904. | | | | | | | | |
| January | 46 | − 6 | 20.25 | 16 | 1 | 1 | 29 | 23 |
| February | 40 | − 6 | 17 | 3.8 | 11 | 5 | 13 | ---------- |
| March | 54 | −10 | 26.82 | 1.5 | 19 | ---------- | 12 | 7 |
| April | 62 | 26 | 45.96 | 7.75 | 10 | ---------- | 20 | 16 |
| May | 69 | 27 | 44 | 16 | 3 | 5 | 23 | 18 |
| June | 66 | 35 | 49 | 10.6 | 5 | 6 | 19 | 19 |

### McHENRY INLET. John C. Callbreath, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| July[a] | 63 | 44 | 53 | 5.1 | ---------- | 1 | 10 | 11 |
| August | 75 | 41 | 54.85 | 1.84 | 10 | 8 | 11 | 9 |
| September | 67 | 35 | 50.4 | .22 | 4 | 6 | 20 | 24 |

### PETERSBURG. J. A. Goding, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| July | 70 | 35 | 52.3 | 9.2 | 2 | 7 | 22 | 21 |
| August | 76 | 34 | 52.8 | 1.93 | 16 | 6 | 9 | 8 |
| September | 64 | 30 | 44.15 | 15.33 | 6 | 5 | 19 | 7 |

### JUNEAU. S. J. Sharick, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| August | 75 | 42 | 31.7 | 5.45 | 9 | ---------- | 3 | ---------- |
| September | 65 | 37 | 50.2 | 6.94 | 6 | ---------- | 1 | ---------- |
| 1904. | | | | | | | | |
| April | 60 | 20 | 42.8 | 7.83 | 17 | 1 | 12 | ---------- |
| May | 65 | 30 | 48.05 | 6.7 | 20 | 3 | 8 | ---------- |
| June | 68 | 31 | 49.3 | 10.66 | 15 | ---------- | 15 | ---------- |
| July | 69 | 42 | 57.1 | 7.15 | 11 | ---------- | 17 | 3 |
| August | 74 | 36 | 54.2 | 4.04 | 24 | ---------- | 7 | ---------- |
| September | 68 | 32 | 49.3 | 9.68 | 15 | ---------- | 15 | 1 |

### SKAGWAY. H. D. Clark, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| October | 55 | 22 | 40.5 | 9.99 | 7 | 3 | 21 | 17 |
| November | 44 | 10 | 28.07 | 1.6 | 7 | 11 | 12 | 7 |
| December | 47 | 17 | 33.69 | 3.35 | 4 | 6 | 21 | 8 |
| 1904. | | | | | | | | |
| January | 43 | −11 | 21.0 | 1.44 | 7 | 11 | 13 | 10 |
| February | 32 | − 3 | 10.7 | ---------- | 25 | 5 | 4 | ---------- |
| March | 52 | 2 | 22.79 | .33 | 21 | 7 | 3 | 3 |
| April | 58 | 27 | 41.25 | 2.31 | 5 | 13 | 12 | 4 |
| May | 68 | 27 | 47.5 | .84 | 10 | 17 | 4 | 6 |
| June | 70 | 33 | 51.7 | .97 | 3 | 15 | 12 | 6 |
| July | 77 | 39 | 56.4 | 1.07 | 3 | 16 | 12 | 6 |
| August | 80 | 31 | 56.9 | .18 | 8 | 16 | 7 | ---------- |
| September | 67 | 32 | 47.4 | 2.8 | 7 | 12 | 11 | 6 |

[a] July for 11 days.

*Meteorological observations*—Continued.

KILLISNOO. Joseph Zuboff, observer.

| Month. | Temperature. | | | Total precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| 1903. | ° *F.* | ° *F.* | ° *F.* | *Inches.* | | | | |
| October | 55 | 26 | 42.9 | 12.45 | 2 | 1 | 4 | 24 |
| November | 50 | 15 | 33.5 | 3.65 | 3 | 5 | 5 | 16 |
| December | 47 | 25 | 36 | 5 | 2 | 4 | 7 | 18 |
| 1904. | | | | | | | | |
| January | 47 | 3 | 27.9 | 4.3 | 5 | 4 | 2 | 20 |
| February | 38 | 7 | 19.2 | 1.25 | 19 | 4 | 1 | 5 |
| March | 46 | 13 | 27.6 | 1.2 | 17 | 3 | 5 | 6 |
| April | 54 | 30 | 40.7 | 1.35 | 1 | 11 | 19 | 13 |
| May | 59 | 28 | 45.4 | 1.75 | 2 | 11 | 9 | 9 |
| June | 63 | 35 | 49 | 3.35 | .......... | 11 | 3 | 16 |
| July | 63 | 38 | 51.05 | 4.6 | .......... | 8 | 3 | 20 |
| August | 70 | 41 | 53.5 | 2.3 | 11 | 10 | 5 | 5 |
| September | 65 | 32 | 47.7 | 7.7 | 3 | 4 | 3 | 20 |

ORCA. W. J. Shephard, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| October | 54 | 28 | 38.15 | 17.6 | 4 | 6 | 21 | 19 |
| November | 47 | 15 | 30.98 | 13.24 | 6 | 8 | 16 | 13 |
| December | 44 | 24 | 33.95 | 23.44 | 2 | .......... | 4 | 18 |
| 1904. | | | | | | | | |
| January | 42 | 11 | 27.55 | 11.59 | 9 | 3 | 17 | 11 |
| February | 38 | 8 | 25.65 | .......... | 19 | 8 | 2 | .......... |
| March | 52 | 11 | 34 | 72 | 16 | 11 | 1 | .......... |
| April | 58 | 30 | 38.85 | 13.55 | 4 | 16 | .......... | 8 |
| May[a] | 65 | 31 | 43.88 | 4.7 | 3 | 5 | 7 | 4 |
| June[b] | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| July[b] | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| August[b] | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| September | 84 | 34 | 35.85 | 9.12 | 10 | 19 | 13 | .......... |

FORT LISCUM. C. J. Bartlett, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| October | 50 | 16 | 33.65 | 6.62 | 15 | .......... | 16 | 16 |
| November | 42 | 4 | 23.31 | 5.62 | 15 | .......... | 15 | 17 |
| December | 43 | 12 | 28.09 | 9.61 | 5 | .......... | 26 | 20 |
| 1904. | | | | | | | | |
| January | 42 | −7 | 22.58 | 6.8 | 15 | .......... | 15 | 16 |
| February | 42 | 2 | 21.89 | .5 | 21 | .......... | 8 | 1 |
| March | 49 | 5 | 24.79 | .1 | 25 | .......... | 6 | 1 |
| April | 52 | 22 | 36.2 | 4.5 | 7 | .......... | 23 | 20 |
| May | 58 | 30 | 43.86 | .68 | 16 | .......... | 15 | 14 |
| June | 61 | 36 | 48.24 | 2.15 | 6 | .......... | 24 | 16 |
| July | 66 | 38 | 48.77 | 5.61 | 6 | .......... | 25 | 20 |
| August | 75 | 34 | 11.67 | 12.75 | 5 | .......... | 26 | 21 |
| September | 70 | 30 | 44.73 | 7.96 | 12 | .......... | 18 | 13 |

SUNRISE. A. Lawson, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| October | 52 | 8 | 32.5 | 2.61 | 8 | 5 | 18 | 11 |
| November | 38 | −15 | 17.2 | 3.37 | 9 | 3 | 18 | 12 |
| December | 48 | 4 | 25.3 | 3.7 | 8 | 8 | 15 | 12 |
| 1904. | | | | | | | | |
| January | 40 | −21 | 11.5 | 1.69 | 13 | 3 | 15 | 10 |
| February | 31 | −16 | 8.7 | .13 | 25 | 2 | 2 | 8 |
| March | 42 | −11 | 16.4 | .28 | 25 | 3 | 3 | 8 |
| April | 56 | 20 | 35.4 | 5.08 | 4 | 4 | 22 | 21 |
| May | 62 | 27 | 44 | 1.01 | 13 | 12 | 6 | 8 |
| June | 68 | 31 | 49 | 1.36 | 11 | 7 | 12 | 15 |
| July | 70 | 34 | 51.2 | 1.05 | 6 | 11 | 14 | 18 |
| August | 76 | 31 | 51.4 | 5.2 | 4 | 6 | 21 | 24 |
| September | 70 | 20 | 44.2 | 2.33 | 13 | 3 | 14 | 16 |

[a] 15 days in May.

[b] Not reported.

*Meteorological observations*—Continued.

TYOONOK. Durell Finch, observer.

| Month. | Temperature. | | | Total precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| **1903.** | ° F. | ° F. | ° F. | Inches. | | | | |
| September | 68 | 28 | 49.2 | 2.76 | 17 | 2 | 11 | 26 |
| October | 52 | 12 | 34.6 | 1.15 | 11 | 1 | 19 | 6 |
| November | 39 | − 8 | 21.1 | .64 | 12 | .......... | 18 | 4 |
| December | 41 | 3 | 27.6 | .57 | 7 | .......... | 24 | 8 |
| **1904.** | | | | | | | | |
| January | 35 | −15 | 12.4 | 1.07 | 13 | 1 | 17 | 7 |
| February | 27 | −11 | 14.1 | 3 | 26 | .......... | 3 | 1 |

WOOD ISLAND. Rev. Curtis P. Coe, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| **1903.** | | | | | | | | |
| September | 71 | 32 | 54.4 | 7.95 | 3 | 1 | 26 | 14 |
| October | 54 | 29 | 40.74 | 6.27 | 5 | 6 | 20 | 14 |
| November | 53 | 11 | 33.11 | 8.8 | .......... | .......... | .......... | 15 |
| December | 45 | 24 | 35.25 | 5.20 | 4 | .......... | 27 | 21 |
| **1904.** | | | | | | | | |
| January | 53 | 8 | 28.41 | 2.03 | 7 | 4 | 20 | 24 |
| February [a] | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| March | 47 | 11 | 28.45 | .......... | .......... | .......... | .......... | .......... |
| April | 48 | 24 | 37.47 | 3.69 | 7 | 5 | 18 | 20 |
| May | 60 | 31 | 41.93 | 3.35 | .......... | .......... | 9 | 7 |
| June | 66 | 35 | 50.26 | 2.26 | .......... | .......... | .......... | 11 |
| July | 68 | 42 | 52.37 | 1.96 | 19 | .......... | 12 | 11 |
| August | 69 | 42 | 53 | 4.98 | 5 | .......... | 26 | .......... |
| September | 65 | 40 | 50.8 | .03 | 16 | 12 | 1 | 10 |

COAL HARBOR, UNGA ISLAND. Henry S. Tibbey, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| **1903.** | | | | | | | | |
| October | 55 | 22 | 37.5 | 2.52 | 7 | 9 | 15 | 13 |
| November | 41 | 18 | 30.7 | 2.54 | 8 | 6 | 16 | 21 |
| December | 46 | 19 | 31.9 | 4.75 | 7 | 4 | 20 | 21 |
| **1904.** | | | | | | | | |
| January | 39 | 8 | 26.2 | 2 | 13 | 8 | 10 | 16 |
| February | 50 | − 1 | 22.7 | .......... | 17 | 6 | 6 | .......... |
| March | 51 | 10 | 29 | 2 | 13 | 5 | 10 | .......... |
| April | 45 | 29 | 31.25 | 9.35 | 7 | 8 | 15 | .......... |
| May | 52 | 31 | 39.95 | 30.8 | 13 | 2 | 14 | .......... |
| June | 61 | 35 | 45.9 | 1.21 | 9 | 4 | 17 | 9 |
| July | 70 | 39 | 50.3 | 4.22 | 6 | 4 | 21 | 20 |
| August | 60 | 41 | 49.5 | 4.17 | 2 | 6 | 23 | 21 |

MINE HARBOR, HERENDEEN BAY. Capt. J. Ducan, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| **1903.** | | | | | | | | |
| September | 58 | 31 | 48.3 | 5.1 | 1 | 1 | 28 | 27 |
| October | 55 | 18 | 36.7 | 3.97 | 3 | 2 | 26 | 24 |
| November | 40 | 15 | 28.7 | 2.6 | 2 | 1 | 27 | 20 |
| December | 43 | 13 | 30 | 5.92 | 3 | 1 | 27 | 14 |
| **1904.** | | | | | | | | |
| January | 39 | − 2 | 23.3 | 3 | 6 | 2 | 23 | 11 |
| February | 41 | − 7 | 21.2 | .49 | 8 | .......... | 21 | 4 |
| March | 44 | 4 | 23.6 | .30 | 6 | 1 | 24 | 6 |
| April | 45 | 3 | 28.05 | 1.42 | .......... | 1 | 29 | 14 |
| May | 53 | 22 | 37 | .81 | 4 | .......... | 27 | 14 |
| June | 58 | 31 | 43.5 | 1.30 | .......... | 3 | 26 | 7 |
| July | 65 | 37 | 47.7 | 3.79 | 1 | 3 | 27 | 21 |
| August | 79 | 40 | 51.5 | 4.25 | 4 | .......... | 27 | 24 |

[a] Not reported.

*Meteorological observations*—Continued.

NUSHAGAK. J. Kahlen, observer.

| Month. | Temperature. | | | Total precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| 1904. | ° *F.* | ° *F.* | ° *F.* | *Inches.* | | | | |
| July | 79 | 39 | 18 | 2.47 | 9 | 6 | 16 | 13 |

CANDLE. R. S. Dimmick, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| October [a] | 37 | −21 | 11.00 | .......... | 11 | 3 | 2 | 1 |
| November | 27 | −27 | .62 | .......... | 10 | 2 | 14 | .......... |
| December | 31 | −35 | 2.8 | .......... | 9 | .......... | 20 | .......... |
| 1904. | | | | | | | | |
| January | 23 | −46 | − 7 | .......... | 7 | .......... | 23 | .......... |
| February | 28 | −44 | −64 | .......... | 9 | .......... | 18 | .......... |

KOTZEBUE. Dana Thomas, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| January | 22 | −50 | −13.45 | .......... | .......... | .......... | .......... | .......... |
| February | 34 | −32 | − 5.25 | .......... | .......... | .......... | .......... | .......... |
| March | 34 | −18 | 5.69 | .......... | .......... | .......... | .......... | .......... |
| April | 45 | 10 | 15.55 | .......... | .......... | .......... | .......... | .......... |
| May | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| June | 66 | 30 | 44 | .......... | .......... | .......... | .......... | .......... |

POINT BARROW. H. R. Marsh, M. D., observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| November | 13 | 26 | − 7.48 | .......... | 12 | .......... | 18 | .......... |
| December | 24 | −29 | − 8.35 | .......... | 15 | .......... | 16 | .......... |
| 1904. | | | | | | | | |
| January | − 6 | −40 | −24.75 | .......... | 25 | .......... | 6 | .......... |
| February | −25 | −38 | −12.95 | .......... | 17 | 1 | 11 | .......... |
| March | 33 | −39 | − 2.63 | .......... | 15 | 6 | 9 | .......... |
| April | 30 | −36 | 1.6 | .......... | 21 | .......... | 9 | .......... |

FORT GIBBON. Frederick F. Simmons, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| September | 68 | 17 | 40.73 | 0.48 | 24 | 3 | 3 | 2 |
| October | 47 | −23 | 12.57 | .22 | 21 | 4 | 6 | 8 |
| November | 24 | −40 | − 6.48 | .33 | 26 | 2 | 2 | 2 |
| December | 24 | −30 | − .64 | .......... | 15 | 7 | 9 | .......... |
| 1904. | | | | | | | | |
| January | −20 | −53 | −19.1 | .08 | 19 | 7 | 5 | 2 |
| February | 18 | −51 | −16 | .55 | 16 | 9 | 4 | 4 |
| March | −45 | −47 | −30.64 | .35 | 17 | 7 | 7 | 8 |
| April | 54 | −12 | 25.7 | .09 | 21 | 8 | 1 | 1 |
| May | 68 | 25 | 23.7 | .22 | 25 | 4 | 2 | 2 |
| June | 85 | 39 | 62.76 | .53 | 24 | 3 | 3 | 1 |
| July | 80 | 50 | 62.19 | 1.95 | 11 | 10 | 10 | 10 |
| August [b] | 75 | 57 | 50.55 | 3.8 | 16 | .......... | 14 | 11 |

FORT EGBERT. John B. Clayton, observer.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| August | 81 | 20 | 53.34 | 2.97 | 13 | 3 | 15 | 12 |
| September [c] | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| October [c] | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |

[a] 19 days in October.
[b] 5 days in August.
[c] Not reported.

## *Meteorological observations*—Continued.

### TEIKHIL. Joseph H. Embleton, observer.

| Month. | Temperature. | | | Total precipitation. | Weather conditions (number of days). | | | |
|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Daily mean. | | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
| 1904. | *° F.* | *° F.* | *° F.* | *Inches.* | | | | |
| March | 46 | −24 | 18.5 | 0.5 | 17 | 3 | 11 | |
| April[a] | 58 | 10 | 35.35 | 7.25 | 9 | 3 | 18 | 2 |
| May | | 16 | | .4 | 12 | 1 | 18 | |
| June | | 28 | | 7.9 | 15 | 4 | 11 | 3 |
| July | | 28 | | 1.53 | 7 | 3 | 21 | |
| August | 100 | 25 | 51.5 | 2 | 12 | 3 | 16 | |
| September | 70 | 11 | 40.5 | 1.21 | 12 | 2 | 16 | 14 |

### CHESTOCHENO. Ray M. Martin, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| April[b] | 60 | 25 | 42.00 | | 7 | | | |
| May[c] | | | | | | | | |
| June[c] | | | | | | | | |
| July | 89 | 41 | 50.33 | | 16 | 3 | 10 | 2 |
| August | 86 | 27 | 53.4 | 4.01 | 14 | 9 | 8 | 12 |
| September | 65 | 15 | 36.03 | 2.01 | 16 | 6 | 8 | 9 |

### TANANA CROSSING. John A. Perry, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| May | 68 | 23 | 45.2 | 0.76 | 15 | 7 | 9 | 6 |
| June[c] | | | | | | | | |
| July | 76 | 30 | 52.4 | .78 | 15 | 10 | 6 | 4 |
| August | 79 | 23 | 48.45 | .89 | 16 | 12 | 3 | 2 |
| September | 63 | 3 | 29.08 | .96 | 14 | 11 | 5 | 3 |

### KETCHEMSTOCK. Daniel B. McCarthy, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| May | 60 | 19 | 32.1 | 0.81 | 5 | 26 | | |
| June | 70 | 27 | 48.2 | .83 | 4 | 24 | 2 | |
| July | 76 | 27 | 51.7 | 2.23 | 3 | 23 | 4 | |

### FORT YUKON. Leonidas J. H. Wooden, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| 1903. | | | | | | | | |
| September | | 18 | | 1.7 | | | | |
| October[d] | 40 | −15 | 27.3 | 12.8 | | | | |
| November | 12 | −41 | 36.45 | 2.6 | | | | |
| December[e] | 26 | −36 | 32.03 | 3.8 | | | | |
| 1904. | | | | | | | | |
| January[f] | −2 | −61 | | 6.9 | | | | |
| February | | −55 | | 9.2 | | | | |
| March | | −45 | | .8 | | | | |
| April[g] | | −14 | | 4.8 | | | | |
| May[h] | 73 | 24 | 45.68 | 5 | | | | |
| June[i] | 83 | 27 | 56.1 | 2.5 | | | | |
| July[j] | 82 | 43 | 66.5 | 11.9 | | | | |

### COLDFOOT. Frank E. Howard, observer.

| Month. | Maximum. | Minimum. | Daily mean. | Total precipitation. | Clear. | Partly cloudy. | Cloudy. | Rain or snow. |
|---|---|---|---|---|---|---|---|---|
| 1904. | | | | | | | | |
| February | 20 | −46 | −18.56 | 3.5 | 17 | | 12 | 11 |
| March | 41 | −43 | .80 | 2.5 | 13 | 8 | 10 | 15 |
| April | 56 | −19 | 27 | .9 | 9 | 7 | 14 | 5 |
| May | 76 | 25 | 44.1 | .6 | 16 | 7 | 8 | 3 |
| June | 82 | 29 | 51.75 | 1.25 | 14 | 8 | 8 | 8 |
| July | 81 | 34 | 59 | 3 | 8 | | 23 | 9 |

[a] Maximum for 26 days in April.
[b] 7 days in April.
[c] Not reported.
[d] October maximum for 21 days, minimum 25 days.
[e] December maximum for 28 days.
[f] January maximum for 10 days.
[g] April maximum for 7 days.
[h] May maximum for 23 days.
[i] June maximum for 24 days.
[j] July maximum for 30 days.

# ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1904.

By Jared G. Smith, *Special Agent in Charge.*

The work of the Hawaii Agricultural Experiment Station has been a continuation of the various lines of investigation described in previous reports. As stated in the preliminary report, the funds of the station have been largely invested in acquiring an equipment of buildings, tools, apparatus, and books, without which it is difficult to undertake investigations and experiments. Much of the time of the special agent has been devoted to superintending building, clearing, and other operations of a similar character, and the station now possesses a modest laboratory for chemical and entomological investigations and a good reference library well developed along the lines of tropical agriculture, horticulture, chemistry, and entomology, which are housed in comfortable buildings.

## BUILDING OPERATIONS.

A new insectary, 12 feet 6 inches by 25 feet, with glass sides and roof, concrete floor, benches, breeding cages, and water fixtures, was built adjacent to the entomological laboratory, and two small cottages for laborers and an addition to one of the stables were also built. The Territorial legislature appropriated $3,000 toward the construction of a fire-proof library, office, and laboratory building (Pl. XIV, fig. 1), and $1,500 for a chemist's residence. These sums were wholly inadequate for their purposes, and to prevent losing them entirely an arrangement was made by which the station supplied certain features. In addition to the residence for the chemist, the station built a four-room cottage for the use of the entomologist. These and the other buildings have been painted, some grading has been done, and additional roads constructed. The water supply of the station proved inadequate for laboratory and other purposes last year, and in order to overcome this difficulty and provide a supply for irrigation purposes a drainage shed was erected on the higher portion of the station grounds, where there is an abundance of rain, and two 10,000-gallon tanks were constructed to provide a better and more permanent water supply. These operations, which were believed to be essential to the station, have made a serious inroad on its income, and have to a degree caused a temporary cutting down of some of the investigations planned for the year, but it is believed that with the beginning of the fiscal year 1906 the station will be in a position to do as good work and as much of it, considering the number of scientists employed, as at many of the older institutions. A telephone line has been erected connecting the various buildings with each other and with the city system. Four acres of land surrounding the main office has been placed in a first-class condition and will be used for plat experiments. About 15 additional acres of pasture land have been fenced and cleared of guava and lantana. Considerable additions have been made to the library through purchases and exchanges, so that the station now possesses the best working library in subjects relating to agriculture in the Territory.

## FUNDS.

As stated in the annual report for 1903, the Territorial legislature appropriated $5,000 per year for two years for assistance to the station and $1,000 as a part of the salary of the station chemist. At a special session of the legislature the appropriation for the station was cut down to $2,730, and the amount set aside for the chemist's salary was cut out entirely. This action was necessary for reasons of economy. The falling off of the revenue of the islands had been so marked that there were not sufficient funds to supply the needs of the local government, and the station was made to feel the necessity for retrenchment. It is unfortunate that this local support has been lost. The station is maintained for the benefit of the agriculture of the islands, and even a small appropriation from Territorial funds would serve to bring the station and the interests and industries of the islands into closer relationship.

## COOPERATION WITH TERRITORIAL AUTHORITIES.

The funds appropriated by the Territory are apportioned to various purposes by the board of commissioners of agriculture and forestry, acting on recommendations made by the special agent in charge of the station. About one-half of the funds now available has been set aside for carrying on tobacco experiments on the island of Hawaii. A tract of land has been leased for a number of years and experiments are being made with Sumatra and Habana tobaccos grown in the open and under shade. A preliminary report of this investigation is given elsewhere.

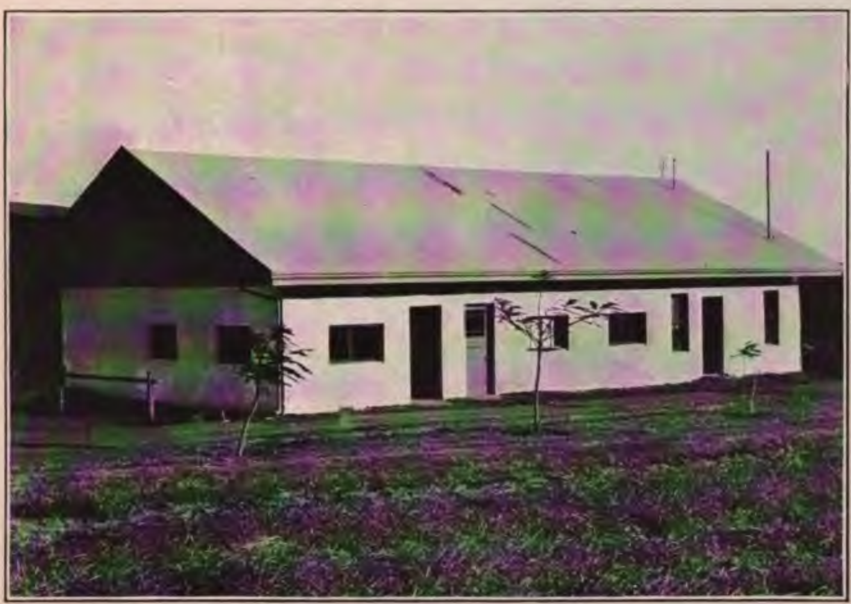

FIG. 1.—NEW OFFICE AND LABORATORY BUILDING AT HAWAII STATION.

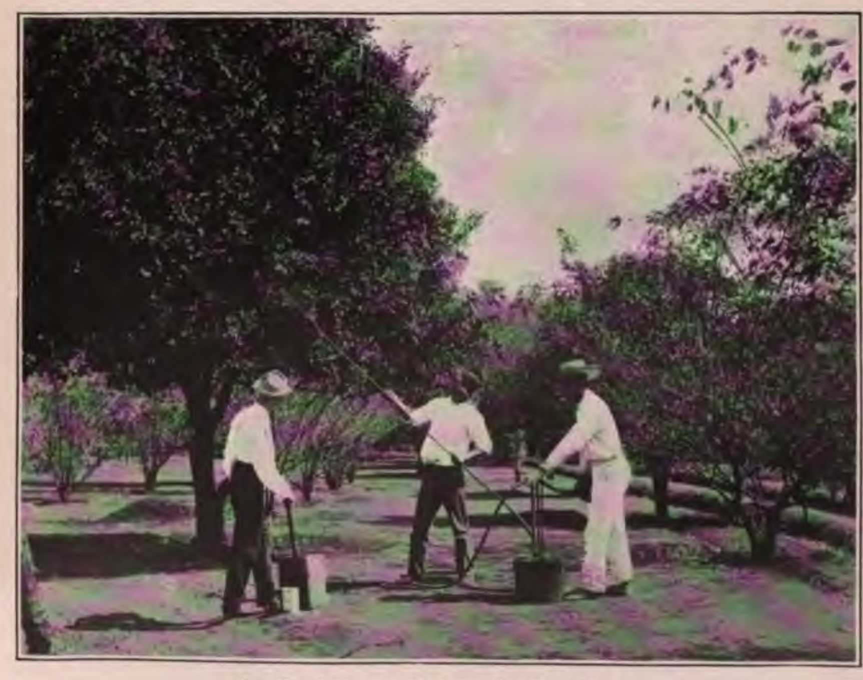

FIG. 2.—SPRAYING ORANGE TREES, HAWAII.

Cooperative experiments in cacao cultivation are being carried on in connection with the board of agriculture and the Hilo Boarding School. The station had on hand a large number of cacao seedlings, and an arrangement was effected by which the growing of this crop is to be investigated through a period running from seven to eight years.

In connection with these cooperative experiments investigations will be carried on upon the selection, propagation, and cultivation of bananas. During the past fiscal year arrangements were effected whereby several hundred banana plants were obtained through the Bureau of Plant Industry of the U. S. Department of Agriculture from Costa Rica, Central America, for planting in Hawaii. These were secured by the courtesy of the United Fruit Company, the only expense being that of transportation. The plants were received in Hawaii, fumigated, and turned over to the station for cultivation, the desire being to establish in the islands a type of banana which will bear shipping better than that now produced for the export trade. It is believed by many that the Bluefields or Central American bananas are superior in shipping and keeping qualities to the Hawaiian varieties, and it was only through the receipt of a large number of plants that this matter could be definitely settled in a comparatively short time.

## INVESTIGATIONS.

The chemist of the station, who was appointed after the beginning of the present fiscal year, was compelled to work with very incomplete facilities until the finishing of the laboratory building. A room in the former office building was fitted up with shelving and tables and used for a laboratory. A gas machine was purchased, together with a limited amount of glassware and other apparatus, and the chemist has devoted a considerable portion of his time to research investigation, studying the composition of some of the organic compounds of the soil. In addition he has made analyses of a large number of samples of forage and fodder plants, a more extended report on which is given in the report of the chemist.

The horticulturist of the station, who submits elsewhere a report, was appointed in October, 1903, and has already issued a bulletin on bananas, which treats of the cultivation and marketing of bananas and brings together information regarding a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of bananas, and a large collection of varieties is being brought together on the station grounds. The horticulturist has also begun experiments in the propagation of mangoes and alligator pears, investigating the possibility of extending the propagation of the more desirable varieties by means of budding, grafting, etc. He also collected and prepared a large exhibit of fruits and horticultural products which was exhibited as a part of the Office of Experiment Stations exhibit in the Government Building at the Louisiana Purchase Exposition.

The entomologist has continued his investigation on the life history of numerous insect pests and prepared a bulletin on the cane leaf hopper, which treats of the life history of the pest, describes the injury produced, and offers suggestions for its control. In connection with this investigation the entomologist visited plantations on the various islands and also investigated a number of other insect enemies of field and garden crops, a report on which is submitted.

The special agent in charge of the station, in addition to attending to the business of the station as director and disbursing agent, has begun the investigation of some of the fungus diseases of coffee and other economic plants, and has made an attempt to bring together the coffee growers of the Hawaiian Islands into an association for their mutual advantage. Letters were addressed through the Department of State to the American consuls in Europe asking for samples and prices of the different grades of coffee, and with these reports as a basis it is believed that something can be done toward developing a market for the superior grades of Hawaiian coffee.

As previously reported, the special agent has begun a comparative test of grasses and forage plants, which is being carried on in cooperation with the Hawaii Live Stock Breeders' Association. Attempts have been made to import and distribute among the members of the association grass and forage-plant seeds from various parts of the world. Some of these seeds were not available through regular seed dealers, but through the efforts of the special agent it has been possible to secure rare seeds and to call the attention of the Stock Breeders' Association to numerous forage plants with which they were not familiar. The distribution of the seed has been made through the secretary of the association and the special agent in charge of the station, the seeds being sent to such localities as they were believed to be adapted to. Among the forage plants under special investigation are fenugreek, sand lucern, sulla, *Paspalum dilatatum*, Mitchell grass (*Astrebla pectinata*), Florida beggar weed, and white branching sorghum. In addition, arrangements have been made to secure seeds of white grama, red grama, side-oats grama, *Panicum bulbosum*, and a number of other species of grasses which are common on the dry land ranges in Southwestern United States. The station is taking up the analysis of fodder plants and grasses, both indigenous and exotic, with a view of obtaining information regarding their actual value.

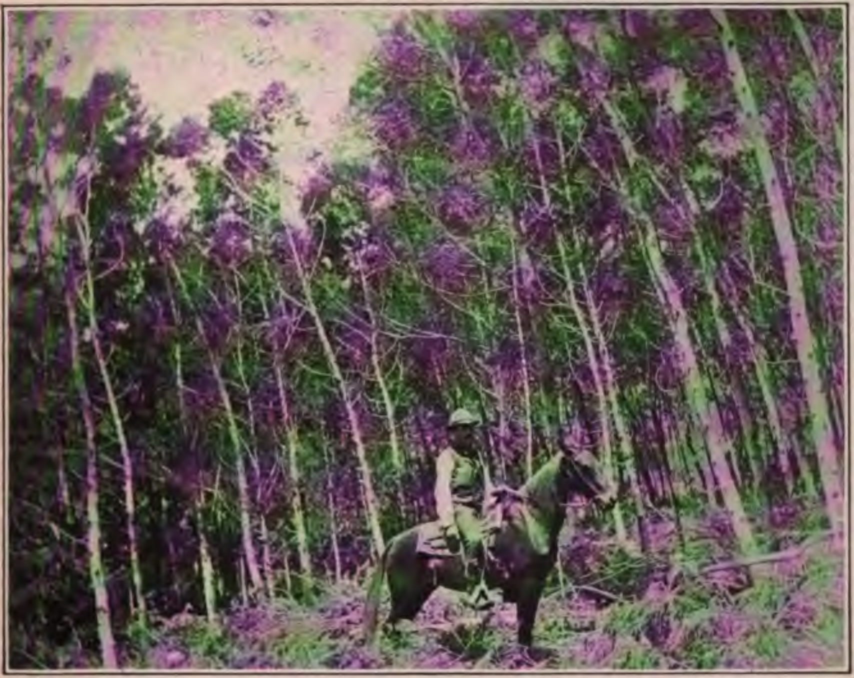

FIG. 1.—BLACK WATTLE PLANTATION, HAWAII.

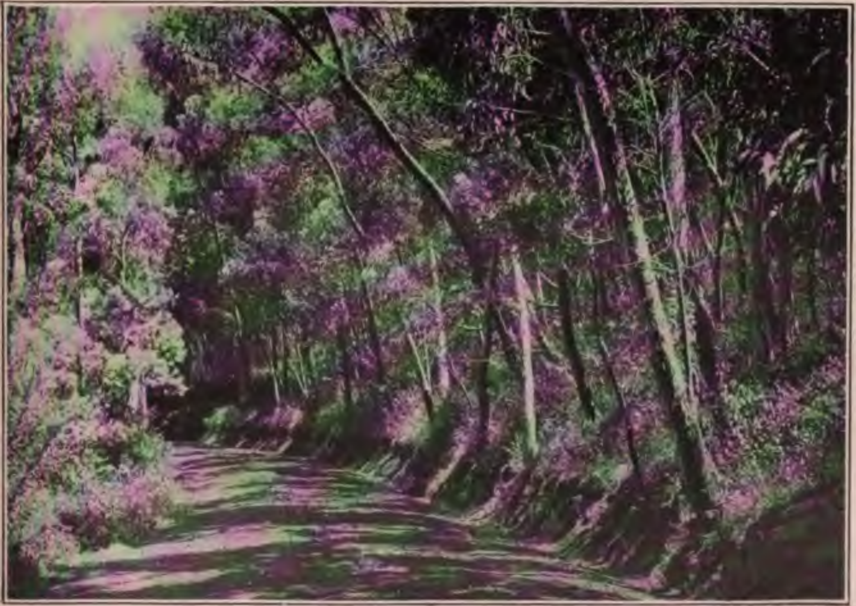

FIG. 2.—EUCALYPTUS PLANTATION, HAWAII.

There are on the station grounds some 5 acres of wattle trees (*Acacia mollissima*) which have been planted for from twelve to fifteen years (Pl. XV, fig. 1). The crop is mature and many of the trees are dying. The bark of these trees is of value for tanning purposes, and it is believed that at least 100 tons of tan bark, containing from 29 to 37 per cent of tannin, valued at from $25 to $35 per ton, can be secured from this plantation. In addition to the tan bark the timber would be available for cord wood, and the amount has been estimated at about 40 cords per acre. It is the intention to prepare and market this product, and if the venture proves a successful one and a market is established for this important tanning material, it is possible that a new industry may be developed, as the trees grow rapidly and produce abundantly. The cultivation of wattle trees has been followed in Natal and other parts of South Africa with success for a number of years, and it is believed that their cultivation can be made a commercial success in many parts of Hawaii. With the present interest in forestry and the necessity for planting denuded areas, it is possible that wattle planting could be followed instead of eucalyptus, which so far has had little value aside from the poles and firewood produced. (Pl. XV, fig. 2.)

## FARMERS' INSTITUTES.

The farmers' institutes, which were organized through the efforts of the officers of the station in 1902, have been continued and have served of great value in bringing together individuals interested in agriculture and in securing the results of each other's practical experience. The appropriation of $300 made by the Territorial legislature was withdrawn by the special session of the legislature, and while this interfered with carrying out the plans to some extent, a number of meetings were held during the past year on the different islands. These were well attended and were largely devoted to the presentation of papers and discussion of topics related to diversified agriculture, and through them valuable data were secured relating to the interests of the small farmer. As an illustration of the range of topics discussed there were presented at the last meeting papers on cassava growing and starch preparation, citrus fruit production, banana growing and shipping, coffee raising, insect pests, etc. The special agent in charge of the station continues as president of the institutes, and Mr. J. E. Higgins is secretary of the organization.

## PUBLICATIONS.

During the year three bulletins of the regular series and five press bulletins were issued.

Bulletin No. 5, A Sugar-cane Leaf Hopper, treats of the introduction of this pest and its distribution throughout the different islands.

Particular attention is paid to the life history of the insect, the entomologist having traced it through the various stages of its life.

Bulletin No. 6, Mosquitoes in Hawaii, was the result of investigations carried on in connection with the mosquito campaign to rid Honolulu of these pests. Notes are given on the distribution and abundance of mosquitoes in Hawaii, followed by a general account of their breeding places, life history, food habits, relation of mosquitoes to disease, and methods of control.

Bulletin No. 7, The Banana in Hawaii, treats of the cultivation of bananas, shipment, their diseases and insect enemies, as well as the various uses to which the banana, both fruit and plant, are put. Notes are given on the principal varieties of bananas in general cultivation, and descriptions are given of a large number of Hawaiian varieties.

Press Bulletin No. 6 is devoted to vanilla cultivation in Hawaii, in which the methods of cultivation, artificial pollination, and fermentation are described.

Press Bulletin No. 7, Mosquitoes, was issued in English, Hawaiian, Portuguese, Chinese, and Japanese. In this bulletin attention is called to the relation of mosquitoes to disease, and directions are given for their destruction, through the clearing up of their breeding places, etc.

Press Bulletin No. 8, The Mealy Bug or "Pear Plight" of the Alligator Pear, treats of what threatened to be a serious insect injury to the avocado or alligator pear growing, and offers practical suggestions for the destruction of the mealy bug.

Press Bulletin No. 9, Two Plant Diseases in Hawaii—Pineapple Disease of Sugar Cane and the Brown-eyed Disease of Coffee, calls attention to destructive diseases of sugar cane and of coffee and offers suggestions for their prevention.

Press Bulletin No. 10, The Pineapple Scale, describes a scale insect which is quite troublesome to pineapples, as well as other plants of economic importance. Various remedies are suggested for its control.

## TOBACCO EXPERIMENTS IN HAMAKUA.

A preliminary report on the tobacco investigations is submitted herewith. In July, 1903, 2½ acres of land were leased by the Secretary of Agriculture from Louisson Brothers, of Honokaa, for the purpose of carrying on tobacco experiments. The land chosen for this work is in the Pohakea tract, about 2 miles above the main government road through Hamakua, at an elevation of 1,600 feet. The land was selected by Mr. F. E. Conter, who visited the Kona, Hilo, and Hamakua districts in April and May, 1903, for the purpose of locating a suitable site for tobacco experiments.

The Hamakua soil is dark brown or black forest loam of very fine texture, light, porous, well drained, and, like all our island forest soils, rich in humus. The mechanical analysis indicates adaptability to the cultivation of the finer qualities of leaf.

Preliminary work was begun in August, 1903, the land plowed to the depth of 12 to 18 inches, the stones removed, and stumps and guava roots grubbed and burned. The field is on the edge of the forest, with a heavy growth of Ohia lehua (*Metrosideros polymorpha*) on three sides. The field was repeatedly harrowed and stirred to get the top soil in fine condition and keep down weeds. Seed beds were made, tools purchased, and a small shed built. Tenting cloth which had been ordered in May was not received at Honolulu until December. In the meantime a frame was constructed to cover 1 acre of ground, and all was in readiness to stretch the tent when the cloth reached Hamakua, in January, 1904. One set of seedlings was grown in the seed beds in anticipation of the early arrival of the tent cloth. These were cared for until too old for use, and, the cloth not having arrived, a new lot had to be started. The best seed having been used in starting the first crop of seedlings, no plants were available for transplanting until from the second crop, in March. The week of March 15 was spent in final cultivation and preparation of the soil. The tenting was stretched on the frame by March 29, and the whole field was planted by April 2. April, 1904, proved an exceptionally rainy month, with unusually low temperatures. There was a fall of 20.17 inches from April 8 to 13, with temperatures of 56° to 63° F. during that time. As a result the losses of transplanted tobacco were very high. On April 17 there was 9.50 inches of rain in twenty-four hours, and the total for April was 38 inches. Replanting had to be done continuously until June 1, so that a full stand was not secured until that date.

By the end of June a few of the plants were ripening their leaves, but too few were in satisfactory condition. Perhaps a hundred pounds of leaf might have been harvested at this time, but there was as yet no drying and curing house, the legislature having in the meantime retrenched its appropriation for this work, so that no funds were available. The diminished appropriation for the new fiscal year became available in July, 1904. A portion of this fund was immediately invested in a small and decidedly inadequate curing barn, new seed beds were built, and a new crop of tobacco from fresh seed sown in them. The leaf from the first crop and from the rattoon crop was harvested as it ripened, in July, August, and September, and cared for as best could be. The pick during these three months amounted to about 1,000 pounds of cured leaf, which was exceedingly variable in quality. The best has been bulked, and is now undergoing fermentation.

Deli, Florida Sumatra, and Java Sumatra comprised the largest portion of the crop. Sumatra tobacco, as has been noted by other experimenters, is quite variable as to habit of plant and form of leaf. Five to seven distinct types or strains are easily separable from the seedlings grown from any lot of imported seed. Some of these types are worthless. The best of them can undoubtedly be fixed by continued careful selection. Besides the Sumatra, a trial was made of Connecticut Broad Leaf, Vuelta Abajo, Connecticut Havana, Florida Havana, and Spanish Zimmer. The quality of the Cuban type tobacco has been uniformly much better than that of the Sumatra.

All of the first crop is now out of the way and a second crop has been planted, from which much better results are to be expected. Some of the experts to whom the raw, cured but unfermented, tobacco has been referred have reported very favorably upon it. Others have stated that it is badly cured and lacking in body; but, from the fact that there has been a wide range of opinion, there is room to hope that results may be better with better facilities for caring for the next crop. There are some points in its favor. The Pohakea tobacco colors well and shows a tendency to run to the dark shades—a good characteristic in both wrapper and filler leaf. The flavor, in so far as it can be determined from the unfermented product, is mild, not rank. The most promising factor is that the burn is good. A cigar rolled from our raw Cuban leaf burns evenly and without char, holds fire, and leaves a white ash.

From the beginning of the experiment careful notes have been taken in regard to every phase of the growth of the crop.

The experiment has hardly been a fair one, because of the numerous delays and the drawbacks attendant upon attempting to grow any new crop on new land in an untried locality. Mr. C. R. Blacow, who has had charge of the work since July, 1904, has the experiment well in hand, so that far better results may confidently be expected as a result of the second season's work. Mr. Blacow is preparing a detailed report on the results thus far accomplished.

I consider the outlook for tobacco cultivation in Hawaii good, provided land suitable for the crop can be placed at the disposal of those who have sufficient capital to engage in this industry. Not every soil is suited for tobacco; and, furthermore, large capital is required for the production and marketing of a high-class article, because of the time required to cure tobacco and get it into marketable shape. Men with limited resources can not afford to wait two or three years until the crop is fermented in bulk and warehouse. But if we can grow fine quality tobacco of either wrapper or filler types there is enough money in the business to tempt investors with large capital. The bulk of our sugar lands is not of the tobacco type. Not all of the coffee lands are suitable for tobacco, although the present experiment is being conducted in a coffee district. Compared with sugar and coffee, there is a far smaller area that could be profitably planted in this crop. Two hundred and fifty thousand acres produces all of the "good" tobacco grown in Cuba. We have perhaps one-tenth of that area on the islands of this group, mainly on Hawaii and Maui, that possesses the physical texture that is a prerequisite to tobacco cultivation.

The question as to whether or not we will be able to grow good tobacco in Hawaii is one which can not be quickly settled. It will require a number of years to demonstrate the matter one way or another. But this demonstration work should be carried on before we ask men to come here and invest their capital in this industry.

## REPORT OF THE CHEMIST.

The appointment of the chemist, Dr. Edmund C. Shorey, dates from September 15, 1903. This station having at that time no laboratory, the chemist's time for the first few months was chiefly occupied in examination and arrangement of the chemical literature in the library and in the preparation of a list of books and periodicals necessary for this important part of a chemist's equipment. The works so selected have been added to this branch of the library, as the means available would permit, there being now 400 bound volumes and a large number of unbound journals and separates; and although small, it is the only collection worthy the name of a chemical library in the Territory.

Through the courtesy of the Territorial board of health the chemist was allowed the use of the laboratory of the food commissioner, and in this laboratory partial analyses of several samples of soil were made during October and November, 1903. During these months there was also made a thorough examination of the soil conditions in two sections on this island (Oahu) and soil samples were collected for future work. The sections covered were the Wahiawa colony and adjacent lands and the experiment station land and adjoining territory on Punchbowl and Tantalus.

In February, 1904, it being evident that the construction of the new laboratory would be unavoidably delayed, a temporary laboratory was fitted up in one room of the building occupied as office and library. The work done in this laboratory was necessarily confined to such as could be done in small space with very simple apparatus. This included determinations of nitrogen in quite a large number of soils; the beginning of a research on the nature of the nitrogen compounds in Hawaiian soils rich in nitrogen, and, as closely bearing on this research, a study of nitrification, denitrification, and soil acidity. With the exception of the nitrogen determinations noted above, this work was confined to one soil. In regard to the nature of the nitrogenous compounds in Hawaiian soils, although the work is but just begun, results have been obtained which are considered important in that they throw some light on the composition of that little-known body or collection of bodies called "humus."

Beginning February 1 the rainfall at the lower end of the station was collected and analyzed, the chlorin, nitrate, and ammonia contents being determined.

Miscellaneous samples were examined and reported on as follows: Five samples of silk fabrics for the customs department; samples of sugar and taro for the Quartermaster's Department, United States Army; samples of flowers of sulphur, and "molascuit" for private parties.

During the last months of the year a beginning was made in the collection, drying, and grinding of samples of Hawaiian-grown fodders, preparatory to analysis of the same.

A list of apparatus necessary for the equipment of the new laboratory has been prepared, and it is expected that this laboratory will be completed and in working order in October, 1904.

Work planned for the year ending June 30, 1905, may be briefly stated as follows:

(1) Continuation of the research on the nature of the nitrogenous compounds in Hawaiian soils.

(2) Analyses of Hawaiian-grown fodders.

(3) Examination of soils and advice regarding the fertilization or cultivation of the same when request is made.

In recognition of the fact that research should be prominent in experiment-station work, the research on the nitrogen compounds in Hawaiian soils will have first place. In Hawaii the soil of a large area of upland open, or likely to be open, for settlement is high in nitrogen and humus, the nitrogen averaging 1 per cent or more and the humus 8 to 14 per cent. Little or nothing is known of the nature of the nitrogen compounds in these soils, or, in fact, in any soils, and our knowledge of humus may be summed up in the statement often made, "It's constitution is not well understood." Now, no matter what the fertility of a soil may ultimately be found to depend upon, there is no question that a knowledge of the constitution of soil ingredients is an important step in the solution of the problem. One per cent of nitrogen, when calculated to nitrate of soda, is equivalent to more than 100 tons per acre to the depth of 1 foot; but in spite of the vast store of nitrogen present in nearly all our soils, the planters of Hawaii spent $1,020,300 for nitrogenous fertilizers in producing the sugar crop of 1903. It is evident that any light thrown on the question how to make more readily available this large store of nitrogen will have an immediate monetary value. The only scientific method of approaching this problem is to ask, What is it which we wish to make available? or, in other words, investigate the constitution of the nitrogenous compounds present in the soil.

A great many requests have come to this station for information regarding the composition of fodders. Up to the present these inquiries have been answered, when possible, by giving published analyses of fodders grown elsewhere. The question whether such fodders as sorghum and alfalfa have the same composition when grown here as elsewhere having come up, and there being in common use quite a number of which no analyses are available, a series of analyses of Hawaiian-grown fodders will be made. These analyses will be made according to the regular scheme for feeding stuffs, with probably determinations of the most important ash ingredients. Such analyses, when published with the proper explanation of their value, will be appreciated by dairymen and ranchers here.

There have been during the year quite a number of requests for analysis of soils and advice regarding fertilizers based on analysis, and with the completion of the new laboratory these requests will probably multiply. There is probably no more unsatisfactory task which can beset an analytical chemist than to give advice regarding the treatment of a soil based on chemical analysis only. This is true of soils anywhere, and the conditions which make it so are accentuated here. Analyses of Hawaiian soils have been made in large number. Experiment station, plantation, fertilizer, and private chemists have been working on them for years, and advice good, bad, and indifferent has been given. In consequence there are a large number of people here who consider chemical analyses of soils of no value whatever, and a perhaps equally large number who have implicit confidence in soil analysis to solve all the problems incident to the growing of crops. This latter class is the more difficult for the soil chemist to deal with, for if he refuses to give advice based on the examination of a handful of soil taken he knows not where or how, and about which he knows absolutely nothing except what is disclosed by the analysis, he is at once classed by them as incompetent.

Again, the official and other methods of analysis commonly used are in many respects not suited to Hawaiian soils. Furthermore, it is recognized that the best results, or in fact the only results from chemical analysis of soils, can be obtained where these have been extended, and are viewed in relation to crop returns, the results of fertilizer tests, climatic conditions, and, in fact, all the factors which enter into crop production. The experiment station of the Hawaiian Sugar Planters is in a position to make this use of soil analysis, but this station has no Hawaiian soil data, and can obtain for present use only that which is most fragmentary and disconnected. Moreover, scientific data of any kind are wholly wanting in regard to the growing of many tropical crops, and the study of the chemical or any other phase of the growing of such crops will have to be de novo.

In meeting requests for soil analyses and advice in cultivation or fertilization based on such analyses, the policy of this station will be first to teach what chemical analysis of soils means, its application and limitation, and to give advice only when all the data bearing on the question are available.

## ENTOMOLOGICAL WORK (D. L. VAN DINE).

The two-roomed building, formerly the office of the station, is now occupied by the entomologist as office, library, and laboratory. Adjoining this building there has been erected during the year a glass-covered structure for use as an insectary. Additional office furniture and laboratory apparatus are needed, some of which have already been ordered, and the balance will be obtained as the means of the station will allow. The entomologist is in need of an assistant, but such an appointment is not possible in respect to more pressing needs of the station. The present range of the investigations of this department could be greatly broadened by such an appointment. More accurate and detailed information could be obtained from the breeding experiments, since an interruption renders previous work incomplete and necessitates repetition. Furthermore, the routine work of the office and laboratory prevents a personal investigation of many problems which can be satisfactorily solved only by careful observations in the field. No great length of time can be spent on any one phase of the work without seriously neglecting other duties.

### CORRESPONDENCE.

The correspondence of this Department has nearly doubled during this second year of work. This can roughly be classed under two heads, (1) communication with the workers on the mainland and in foreign countries, and (2) replies to local inquiries regarding injurious insects. The entomologist is indebted to many workers in the United States and abroad for literature regarding certain pests in particular and for the receipt of available entomological publications in general, and would especially acknowledge the continued help given by Dr. L. O. Howard, Chief of the Bureau of Entomology of this Department and his assistants, in determinations made during the year and references to literature regarding certain species.

## PUBLICATIONS.

The entomological publications for the past year consist of a revised edition of Bulletin No. 3 of the regular series; Press Bulletin No. 7, giving brief directions for ridding door-yards and houses of the breeding places of mosquitoes, printed in English, Portuguese, Hawaiian, Chinese, and Japanese on cardboard to be posted in conspicuous places; and Press Bulletin No. 8, a popular discussion of a mealy bug, *Dactylopius nipæ*, a destructive pest of the alligator or avocado pear, with directions for combating the same.

Two bulletins of the regular series have been prepared for publication during the fiscal year 1905. These deal with subjects that have received special attention and study during the year. One, Bulletin No. 5, entitled "A Sugar-cane Leaf Hopper in Hawaii," is a summing up of investigations begun the previous year on an hemipterous insect belonging to the family Fulgoridæ. This is a recently described leaf hopper (*Perkinsiella saccharicida*), which has invaded the cane fields throughout the islands to a serious extent. The bulletin deals with the introduction of the pest; its life history and habits; the injury to the cane; the symptoms of its work; the limitations of the work of natural enemies in controlling the pest; the natural enemies to be found in the cane fields, and remedies—the control of the pest by active measures and cultural preventive methods. The other bulletin, No. 6, entitled "Mosquitoes in Hawaii," is a discussion of the mosquito problem. It contains information on the introduction of mosquitoes into Hawaii; their distribution and abundance; a general account of the present knowledge of mosquitoes regarding their breeding places, life history, migrations, food, and relation to disease; the common Hawaiian mosquitoes; their natural enemies, and methods of control. A press bulletin on the pineapple scale (*Diaspis bromeliæ*) is completed and will be published as Press Bulletin No. 10. A general detailed report on some fifty species of injurious insects of Hawaii is also in the course of preparation and will be published in bulletin form. Aside from the applied work there is in preparation a technical paper containing the results of a comparative anatomical study of the adult mouth parts of certain families of Hymenoptera.

The entomologist has been active during the year in farmers' institute work and has continued to aid, in an advisory capacity, the citizens' campaign to rid Honolulu and vicinity of mosquitoes.

## A PARTIAL LIST OF THE INJURIOUS INSECTS OF HAWAII.

The most practical arrangement of the injurious insects is in accordance with their hosts or food, irrespective of their scientific classification. A general report concerning the principal injurious insects of Hawaii will be published in bulletin form, following this plan. Later, it is hoped, each group can be carefully worked out more in detail and presented separately. The following list embodies the above idea:

### SUGAR CANE.

The sugar-cane leaf hopper (*Perkinsiella saccharicida*) is a Fulgorid recently introduced from Queensland or China. The loss on last year's crop is estimated to be not less than $3,000,000, the gross value of the entire crop being about $30,000,000. Greatest injury was wrought on the unirrigated plantations situated in the windward districts; epidemic during the winter season, when growth practically ceases; confines its work to cane.

The sugar-cane borer, the larva of *Sphenophorus obscurus* is generally distributed. Until the recent invasion of the leaf hopper this beetle was the most serious pest of cane in the islands; introduced from Tahiti; observed as early as 1865 in the vicinity of Lahaina, island of Maui; determined by the Division of Entomology, U. S. Department of Agriculture, in 1885 from specimens forwarded by King Kalakaua; damage to cane estimated to be $500,000 per annum; not abundant in the dry districts; overirrigation or abundant rainfall favors the development of the pest; may be controlled by burning off and picking; infests also the banana (*Musa* spp.), wine palm (*Caryota urens*), royal palm (*Oreodoxa regia*), the cocoanut palm, and the papaya (*Carica papaya*).

The sugar-cane leaf roller, the larva of *Orneodes accepta*. The larva of this moth of the family Pyraustidæ was recently described for the first time by Doctor Dyar, of the U. S. National Museum, from specimens collected by the entomologist of this station; became serious on limited areas on the mauka loa (extreme mountainward) fields of certain plantations on the island of Hawaii; taken also from Hilo grass (*Paspalum conjugatum*) growing wild above the cane, from which it undoubtedly invaded the cane fields.

A mole cricket (*Gryllotalpa africana*) was reported during the year as injurious to young cane from two plantations on the island of Oahu.

The sugar-cane mealy bug (*Dactylopius calceolariæ*) was found in abundance beneath the lower leaf sheaths in some fields on two of the eleven plantations visited during the year.

Cypress girdler (*Eleutheroda dytiscoides*) was found in large numbers beneath the trash of cane in the Kohala district, island of Hawaii, doing no apparent damage except to basal joints of the lower leaf sheaths; taken also from Monterey cypress in the gulches, doing serious damage by girdling the bark of small limbs and branches; reported also from Kona, same island, as injurious in the same manner to lime trees.

The Maui or Olinda bug (*Aramigus fulleri*) is a well-known beetle on the mainland; common horticultural pest on the islands of Maui and Hawaii; recently injurious to field crops, damaging corn on the island of Maui and Irish potatoes and sugar cane on the island of Hawaii; taken also from "oe" (Verbenaceæ) and guava bordering the cane field, from which plants it undoubtedly invaded the fields.

### COFFEE.

The "coffee blight" (*Pulvinaria psidii*). This scale insect has done serious damage to coffee in some districts; found the past year in abundance on neglected trees in the vicinity of Hilo, island of Hawaii; infests also the guava and certain ferns.

The torpedo bug (*Siphanta acuta*). This leaf hopper occurred in large numbers on coffee in the Hamakua district, island of Hawaii; undoubtedly plays an important part in the dissemination of the brown-eyed disease (*Cercospora coffeicola*) of coffee; taken also from mango, orange, and lime.

The "black fly" of coffee (Aphididæ). Undetermined; abundant on the new growth in the Hamakua district.

### CITRUS TREES.

The following scale insects, with the exception of the latter, are common and abundant on citrus trees.

The purple scale (*Mytilaspis citricola*) and a tropical species of the same genus (*M. pinnæformis*).

The California red scale (*Aspidiotus aurantii*).

The fluted scale (*Icerya purchasi*) was taken the last year from the black wattle (*Acacia decurrens*) and found in abundance on the ironwood (Casuarina); it was received also on twigs of the lime from Kaupo, Maui, where it was reported to be doing serious damage.

### OTHER CITRUS PESTS.

The orange aphis (Aphididæ). Undetermined; very common and abundant on new growth.

The torpedo bug (*Siphanta acuta*). Noted under "Coffee."

### ALLIGATOR OR AVOCADO PEAR.

The pear blight (*Dactylopius nipæ*). This mealy bug is generally distributed and abundant; besides the alligator pear, it infests the fig, guava, grape, and breadfruit.

A scale insect (*Fiorinia fioriniæ*) was found on the under side of the leaves of neglected trees.

### PINEAPPLE.

The pineapple scale (*Diaspis bromeliæ*) and the pineapple mealy bug (*Dactylopius* sp.) are both to be found wherever pineapples are being grown throughout the islands and occur in serious numbers on some plantations.

### MANGO.

The torpedo bug (*Siphanta acuta*). Noted under "Coffee;" accompanied by a "smut," a fungus similar to that following the attacks of certain plant lice (Aphididæ), and followed by a destructive fungus determined at the Bureau of Plant Industry as *Colletotrichum* sp.

### BANANA.

The cane borer, the larva of *Sphenophorus obscurus*. Noted under "Sugar cane."

The banana borer (*Calandra remota*) is common; recorded by Blackburn as infesting "especially stems of cactus and banana," Oahu, 1885. This beetle belongs to the same family as the cane borer Calandridæ.

The banana leaf roller, the larva of *Orneodes blackburni*. The larva of this moth is at times very destructive to the leaves of the banana; infests also the cocoanut palm, and because of its work on this plant is known in some localities as the "cocoanut leaf worm." The cocoanut trees about Honolulu are seriously disfigured by this pest.

### GARDEN PRODUCTS.

The melon fly (*Dacus cucurbitæ*) is a true fly of the family Trypetidæ. The larva infests the fruit of all plants of the family Cucurbitaceæ; destructive also to beans and tomatoes.

Cutworms, the larvæ of *Agrotis* sp. Several species; common and general feeders on garden products; work observed on corn, cabbage, and potatoes.

The cabbage butterfly (*Pieris rapæ*) is very common and destructive.

The cabbage aphis (undetermined) is abundant.

The corn leaf hopper (*Dicranotropis maidis*) belongs to the same family as the sugar-cane leaf hopper; similar to that species, but smaller in size; found on corn and grasses and reported as formerly injurious to cane.

The "green fly" of corn (*Aphis* sp.) injured seriously the corn in the Kula district, island of Maui, the previous season.

The black ground beetle (*Ompatrum serratum*) is a common Tenebrionid which did much damage to ripe strawberries at the station the last season.

### OTHER HORTICULTURAL PLANTS.

The Japanese beetle (*Adoretus umbrosus*) is a general feeder on trees and shrubs, especially destructive to roses and grapes.

The Maui or Olinda bug (*Aramigus fulleri*) is the well-known Fuller's rose beetle of the United States. It is very common in certain districts on the islands of Maui and Hawaii. Where this pest abounds it is equally if not more injurious than the Japanese beetle; previously considered entirely an horticultural pest, but recently attacking the crops of the field. Noted under "Sugar cane."

The peach scale (*Diaspis amygdali*) was found on peaches at Makaweli, Kauai.

The rose scale (*Diaspis rosæ*) is common on roses throughout the islands; reported as infesting the mango.

### TOBACCO.

The tobacco cutworm, the larva of *Agrotis ypsilon*. This species is one of the abundant cutworms noted under "Garden products," especially destructive in seed beds and to young plants in the field; observed at the experimental field of this station, in Hamakua, island of Hawaii.

The tobacco budworm, the larva of *Heliothis obscura*. Known also as the cotton bollworm; as yet not serious, since neither cotton nor tobacco is a common crop.

The tobacco leaf miner, the larva of *Phthorimæa operculella*. Bred from the larvæ infesting the stems of tobacco; taken at the experimental field Hamakua, Hawaii.

The tobacco flea-beetle, *Epitrix parvula*. Common; reported as infesting also the eggplant and poha (*Physalis peruviana*).

### HOUSEHOLD INSECTS.

Mosquitoes (Culicidæ). The three common species are the "night" mosquito (*Culex pipiens*) and the "day" mosquitoes (*Stegomyia fasciata* and *S. scutellaris*). The former species is the abundant mosquito; throughout the Territory it is necessary to screen the houses, or if that can not be afforded, use nets over beds at night and burn buhach powder. During the past year much has been done to lessen the numbers of these pests by the proper treatment of their breeding places.

Cockroaches (Blattidæ). Probably the most disagreeable pests to the housewives are the cockroaches. The three house-frequenting species are: *Periplaneta americana*, *Periplaneta australasia*, and *Ectobia germanica*. The two former species are the common large cockroaches; they infest all sorts of foods stuffs, and cause much damage to starched clothing, books and papers in libraries, and wall paper.

The house fly (*Musca domestica*) is common and periodically abundant in certain localities, but not generally so.

Ants (Formicidæ). Several species; undetermined; as is common in the Tropics, they are very numerous and the cause of much annoyance to housekeepers.

The silver-fish (*Lepisma* sp). Order Thysanura; destructive to books and papers in libraries, food stuffs, and silks and woolens in dry goods stores.

The white ant (*Calotermes marginipennis*). Family Termitidæ; very destructive to timbers in buildings and furniture; another species of the same genus was observed working in live Ohia (*Eugenia malaccensis*) in the Kohala forest.

The carpenter bee (*Xylocopa aeneipennis*) is very destructive to timbers in houses, telephone poles, and fence posts; works for the most part in redwood.

The mud dauber (*Pelopæus* sp). This wasp is a nuisance in houses on account of its habit of building a nest of mud about the ceilings of lanais and rooms.

Clothes moths and a carpet beetle are common and complete the list of household insect pests. Larvæ have been collected and adults will be bred for determination.

### STORED PRODUCTS.

The rice weevil (*Calandra oryza*) was received during the year from Makawao, Maui, infesting stored corn; taken also from tobacco and various food stuffs.

The cigarette beetle (*Lasioderma serricorne*) is a serious pest to stored tobacco and cigars; bred from cigars, red pepper, and "Paprica;" recently received in large numbers by a local firm in a shipment of tobacco.

The bamboo beetle (*Dinoderus minutus*) infests bamboo furniture and baskets; known locally by the Japanese furniture dealers as the "bamboo worm."

The rust-red flour beetle (*Tribolium ferrugineum*) was bred from cracked rice and from a patented stock food.

The bean weevil (*Bruchus obtectus*) was received from Naalehu, Kaui; from stored beans.

### LIVE STOCK.

The horn fly (*Hæmatobia serrata*) is a serious pest on cattle ranges; the extensive area and semiwildness of the stock prevent active measures of control; this pest, together with lack of food and water, often causes death to the animals.

The "night" mosquito (*Culex pipiens*). Noted under "Household insects;" a common disease of young fowls (*Epithelioma contagiosum*) locally known as "sore-head" is due to a parasitic fungus. One source of infection of this disease is undoubtedly through the wounds caused by the bites of this mosquito, the young chicks being unprotected by a growth of feathers.

## HORTICULTURAL INVESTIGATIONS.

The appointment of the horticulturist, Mr. J. E. Higgins, dates from October 3, 1903.

During the first month the work of preparing the exhibit of agricultural products for the St. Louis Exposition was completed. This consisted in packing, labeling, and indexing specimens of the varied agricultural products of the islands. The fruit and other perishable articles were shipped with no other packing than the preserving liquid in which they were immersed. They are reported to have arrived at St. Louis in good condition.

### BANANAS.

A considerable portion of the work of the past eight months has been with bananas. This has been twofold in its nature; a search was made into the literature of the subject, which is quite scattered and fragmentary, and observations and investigations have been made in connection with bananas growing in these islands. The subject has been considered not only from the immediate commercial standpoint, but an attempt has been made to become more familiar with the numerous so-called "native" bananas and to make descriptions of them. This has been a work involving great difficulty. These varieties are scattered throughout the island group, and some of them are becoming exceedingly rare or almost extinct because of the ravages of cattle in the forests and the decadence of an agricultural class among the native Hawaiians. It is generally only the most aged who know anything of these relics of ancient cultivation. The difficulty is further increased by the frequent use of local names for these varieties, thus giving rise to many synonyms. Some of the native forms may prove of considerable commercial value in the future. A collection of over thirty "native" and introduced forms is now in the experimental plats and is being added to as opportunity offers. A bulletin containing the results of these researches has been prepared and is now ready for publication.

An importation of Bluefields banana plants (Jamaica or Martinique variety), which was received by the Territorial board of agriculture and forestry, has been cared for at this station. They are being propagated for distribution later and are at present making a very satisfactory growth.

### THE MANGO.

The mango has received frequent attention throughout the year. Some thirty or forty varieties of the fruit have been collected and studied with more or less care. A few of these may prove to be of commercial value and many more are useful for home consumption.

The grafting of the mango, when the art has become more generally learned, will doubtless make some of the superior varieties more common than they are at present, and will do much to establish a mango industry. This fruit is destined to take a prominent place in the great American markets. Successful experiments in budding the mango have been conducted by the horticulturist, showing that it is perfectly practicable to propagate it by this method in these islands.

A serious disease of the mango was found to be very prevalent in many parts of the islands, which has destroyed a large part of the season's crop. It attacks the flowers and the new leaves, causing them to turn black and die, and also disfigures the fruit. This was first studied at Hilo, where the horticulturist was engaged in field work in connection with bananas. From the very imperfect observations which it was possible to make under these conditions, it was concluded that the disease was probably due to a fungus attack. Specimens of the diseased parts were later forwarded to Dr. A. F. Woods, vegetable physiologist and pathologist of the U. S. Department of Agriculture, who reports that "the fungus, a Colletotrichum, is in fine fruiting stage in the cracked areas in the fruit and in the minute blisters on the twigs, but is less fully developed on the leaves." Through the kindness of Doctor Woods, the matter is being further investigated. During the following season experiments will be conducted in attempting to control the attack by means of fungicides.

### CABBAGE ROT.

A field of cabbage which had been planted as a test of certain varieties was attacked by the black rot, a disease caused by the bacterium *Pseudomonas campestris*. The attack was very severe and afforded the opportunity to study the resistant qualities of different varieties. The results of these observations may be published later.

During almost the entire period while these plants were growing the weather was unusually wet. When the crop was removed the field was immediately prepared for replanting with cabbage plants, the object being to observe the effect of dry weather, since the wet season was then about at an end. Although the disease again appeared it was much less serious than during the rainy weather.

### CACAO EXPERIMENTS.

During the last half of the fiscal year arrangements have been made for conducting experiments in growing cacao. The climate of the Hilo district being better adapted to this culture than that to be found where the station lands are located, the experiments will be carried on there in connection with the agricultural work of the Hilo Boarding School and under the immediate supervision of this station. The work will begin at once.

### AVOCADO PEARS.

During the past season thousands of avocado pears have been wasted or fed to stock. This has been the case for several years. These fruits, if placed in the American markets, would sell for large prices. That it is perfectly possible to place them at least in Pacific coast markets is beyond question. They have frequently been sent to San Francisco, and even greater distances, arriving in good condition. A very successful shipment was made from this station to Manila last season. A considerable shipment of avocadoes was made through the U. S. Department of Agriculture to New York. Most of the fruit reached New York in good condition and sold well upon the market. This experiment was in the nature of a preliminary one to test methods of packing, relative value of varieties for shipment, etc., and if a more extended shipment should prove equally successful, this will open up a new field for the distribution of this fruit.

When the art of budding or grafting these trees shall have been perfected there will be nothing to prevent the avocado from becoming an important article of export from these islands. There are many forms here of excellent flavor and texture and very fine in appearance. The season of ripening, with the different varieties, covers nearly half the year.

### TRAVELING.

During the month of January, 1904, a trip was made to Hilo and the Olaa district and return. This occupied about three weeks, the chief work being the study of bananas and advising those who had recently embarked in commercial banana growing. A similar tour was made of the west side of Hawaii in June, including several days spent at Pohakea in transferring the tobacco experiments from Mr. F. E. Conter, resigned, to Mr. C. R. Blacow. Other traveling of less importance has been performed from time to time as occasion demanded.

# ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION 1904.

By D. W. May, *Special Agent in Charge.*

## INTRODUCTION.

The fiscal year 1903-4 is the second twelve months of the existence of the Porto Rico Experiment Station at its new location, Mayaguez. The farm purchased for the use of the station consists of an old sugar plantation which had been allowed to grow up to brush and grass through a number of years. The work, therefore, during this period has continued to be one largely of preparation. By means of an appropriation from the insular government this work of preparing the estate for experimental purposes has been greatly assisted. Unfortunately, however, it was not completed, and the Territorial legislature failed to appropriate anything for completing this work or for furthering certain experimental work that had been undertaken.

A number of changes occurred in the station staff during the year. Frank D. Gardner, special agent in charge, returned to the Bureau of Soils, U. S. Department of Agriculture, in May, and was succeeded by D. W. May, of the Kentucky Agricultural Experiment Station. J. van Leenhoff, jr., resigned and entered the Bureau of Plant Industry, U. S. Department of Agriculture. E. G. Bowersox has been succeeded as farm superintendent by E. F. Curt. E. C. Howe, clerk and stenographer, has been succeeded by Miss Jessie F. Springer. The position of horticulturist has been filled by the appointment of H. C. Henricksen, of the tropical laboratory of the Bureau of Plant Industry, Miami, Fla. Animal industry will be taken up by the special agent in charge, D. W. May. As soon as the funds of the station will allow a chemist should be added to the staff. This is necessary for the proper study of the soils, fertilizers, cave deposits of guanos, and other resources and products of Porto Rico.

## BUILDINGS AND REPAIRS.

The plant house, a bamboo frame covered with cheese cloth, has proven unsatisfactory for the work, owing to its instability and to the fact that plants in this inclosure were kept too moist, causing damping off. A new plant house has been constructed of wood, the sides built of slats placed far enough apart to allow for the circulation of air.

The lowlands have been drained, thereby permitting better and more constant cultivation. An insular appropriation of $950 was expended for the purpose of tiling these lands, and this amount includes the purchase of a tile-making machine for $300. The system of drainage is working admirably and has already caused a change in the physical condition of the soils.

Another insular appropriation of $650 has been expended for fencing, and while the work is not complete, yet it has enabled us to inclose nearly the entire tract and to build a number of cross lines. The irregular form of the station grounds gives us a border line of something like 4½ miles.

A further insular appropriation of $100 has been used for painting the various buildings of the station.

The sum of $500 of the insular appropriation was used in the coffee investigations, and $500 in the study of tobacco culture on the island. The results of this work are reported herein by J. W. van Leenhoff and J. van Leenhoff, jr., respectively.

By cooperation with the irrigation and drainage investigations of the Office of Experiment Stations, $335 has been expended in a system for irrigating some of the lands of this station. (Pl. XVI, fig. 1.) A dam has been constructed, ditches built, and irrigation will be employed in the production of various crops, and especially in growing lowland rice. (Pl. XVI, fig. 2.) By the use of hydraulic rams the water will also be employed in the propagating gardens and nursery. With a growing season of twelve months in the year and plenty of water available at all times, it is expected to secure very quick and very favorable results. In all about 40 acres will be irrigated.

As detailed in other portions of this report, the continuation of orchard planting is progressing and the other lands of the station are being brought under cultivation as rapidly as possible.

Meteorological observations have been carried on by members of the station staff at Mayaguez, Aguas Buenas, and "La Carmelita" for the Weather Bureau of the U. S. Department of Agriculture.

## TRAVEL.

During the year the special agent in charge made a trip to Washington for conference with the Director of the Office of Experiment Stations and for preparing his annual report. The entomologist and botanist made a trip to Washington and St. Louis. At the latter point he assisted in placing and labeling the Porto Rico Station

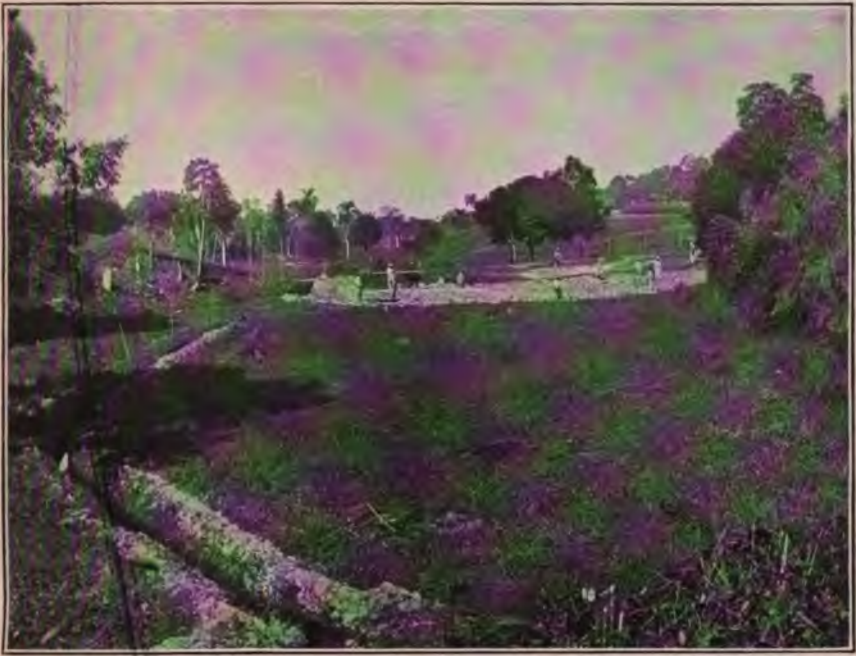

FIG. 1.—DAM CONSTRUCTED FOR IRRIGATION PURPOSES AT PORTO RICO STATION.

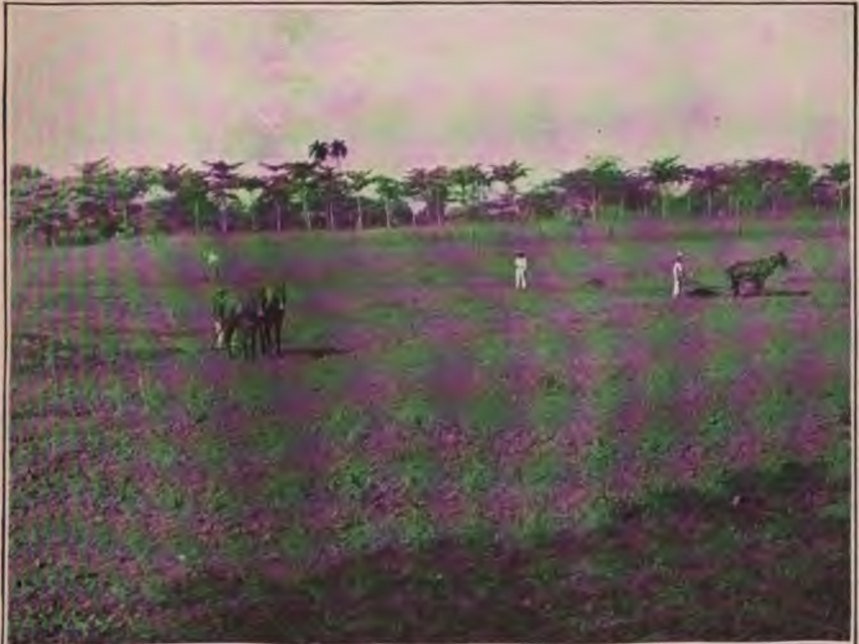

FIG. 2.—FIELD TO BE IRRIGATED.

exhibit at the exposition. Different members of the staff have made numerous trips in and about the island, meeting with fruit growers and other associations and in conference with leading planters.

## LABOR.

The station has employed a great deal of labor during the fiscal year. This has been necessary by reason of the large amount of work required for bringing the station farm into cultivation. Labor varies in price from 40 to 60 cents a day on the plantations. The experiment station has been able to secure excellent hands at from 50 to 55 cents per day. This labor requires, however, constant supervision, as the work is very often new to these men, and they have to be taught the use of new tools and implements.

The administrative work of the station is growing in extent and requires a great deal of the time of the special agent in charge, especially as he is also disbursing agent. Through the efforts of Miss Jessie F. Springer the mailing list has been greatly increased and the names of representative planters secured. This has been accomplished by the assistance of the various alcaldes of the island, who have, upon request, sent in the names of the more progressive farmers in their respective districts.

The station has distributed a large number of packets of seed, a large amounts of Sea Island cotton seed, and various economic plants for trial in different sections of the island.

The equipment of the station has been increased by various tools and implements, including a mower, and by the purchase of four American mules.

## PUBLICATIONS.

During the year the Porto Rico Station has issued one bulletin and two circulars.

Bulletin No. 4, Propagation and Marketing of Oranges in Porto Rico, describes the various methods of propagating oranges, gives directions for the formation of seed beds and nurseries, and transplanting and cultivation of the orange, and offers suggestions for picking, grading, packing, and shipping oranges to market.

Circular No. 4, Control of the Brown Ant, gives an account of the injury caused by the brown ant (*Solenopsis geminata*) in orange orchards, where it frequently causes extensive damage, particularly to young trees, by girdling them in its attempt to secure a rapid flow of gum from the trees. Experiments with girdle paints showed that a cheap and efficient means of combating the ants was possible.

Circular No. 5, Coffee Planting in Porto Rico, describes the investigations that have been carried on by the experiment station in the improvement of an old coffee plantation and in the establishment of a new one. The information is drawn from investigations carried on at the Carmelita Substation.

## AGRICULTURAL POSSIBILITIES.

A great many inquiries are received from time to time from persons in various States, as well as local parties, regarding the agricultural possibilities of Porto Rico. It is the aim of the station to obtain such information as will enable it to answer inquiries fully, and to place before the people of the island and investors the possibilities in agriculture. Horticultural enterprises are under way in several parts of the island, especially orange planting, and it seems probable that such products will ultimately form an important part of our exports. For a quick-growing export crop sugar is at present the most developed and forms the larger part of our shipments. Much remains to be done in the way of fertilizing and cultivating this crop to get the highest returns.

No doubt certain market-garden crops can be profitably grown on the island for the New York market, and the station now has under way the development of this branch of agriculture. Arrangements have been made with the New York and Porto Rico Steamship Company to handle shipments of perishable fruits and vegetables expeditiously. The results, financial and otherwise, of trial shipments to the States will be published from time to time in the reports of the station and in the newspapers of the island.

Aside from horticultural and field products the island exports a great many horses and cattle. There is a great need, however, for the introduction of better blood, and it is to be hoped that the insular legislature at its forthcoming session will appropriate an amount sufficient to enable the station to equip itself with some blooded horses, cattle, pigs, and poultry. No doubt live stock of superior quality can be grown upon the island, and the native horses and cattle will lend themselves very readily to improvement by the introduction of pure-blooded stock.

The growing of rice needs investigation and encouragement. The small amount now grown upon the island indicates that it can be made profitable, and as this staple forms a considerable part of the food of the inhabitants its growth would stop the large importations now made.

Certain fiber crops would doubtless prove profitable for Porto Rico, especially the growing of Sea Island cotton. From reports received from various sections of the island the indications are that this plant will do well here if properly fertilized and cultivated. The station has under way experiments in growing Sea Island cotton, paying especial attention to the fertilization of the soil for this crop.

More forage crops, and especially the growing of legumes, are much to be desired. A number of legumes are under investigation, both at Mayaguez and the substation at "La Carmelita." At the latter place alfalfa and red clover are very promising, and at Mayaguez very good results have been obtained with velvet beans. By inoculating the various legumes with material obtained from the Bureau of Plant Industry the outlook with velvet beans, cowpeas, and other legumes is more promising than indicated in the last report.

One of the greatest problems confronting the agriculturist in Porto Rico is the proper fertilization of his crops, whether they be of the field, garden, or orchard. The continuous cropping of the soils for several hundred years has resulted in the great depletion of their fertility, especially as their culture is often accompanied by torrential rains that tend to wash away the surface soil in many places. The use of artificial fertilizers is comparatively recent in Porto Rico, and for the present extends to only a few of the more progressive sugar planters. Information upon the proper use of fertilizers is much to be desired, and at the same time a Territorial law covering the analysis and inspection of fertilizers sold in Porto Rico is highly important. This matter will be brought to the attention of the legislature at its coming session in urging the passage of an inspection law that will safeguard the planter and encourage the increased use of fertilizers. In this connection it will be necessary to provide for the services of a chemist, which is very much needed in the work of the station.

The station is cooperating with the public schools of Mayaguez in carrying out a system of school gardens, with the hope of interesting the coming generation in agricultural pursuits. It is important that in the scheme of education in the island attention be paid to certain practical affairs, of which agriculture is destined to remain chief. A school garden would be especially important because of the fact that while many of the people are extremely poor they fail to have gardens growing about their little houses, depending wholly upon nature to provide some of the necessaries of life that might be easily procured with a little labor. The station is endeavoring to encourage the planting of gardens by the men working in the various departments. Seeds and manures are furnished and every encouragement given them to plant gardens about their houses for their own good and as an example to their neighbors.

## REPORT OF O. W. BARRETT, ENTOMOLOGIST AND BOTANIST.

During the past year the work was almost exclusively of a horticultural nature, but very few specimens have been added to the herbarium, and the entomological work was largely of an economic nature.

During July and August attention was directed largely to the preparation of the 25-acre orchard and the assembling of the 85 varieties of fruits and economic trees in the nurseries. Planting of the orchard was begun in September and finished in December. A wind-break, composed of mamey (*Mammea americana*), guamá (*Inga vera*), mango (*Mangifera indica*), and rose apple (*Jambosa vulgaris*), was set on the east side of the experimental plats tract; volunteer 1-year-old seedlings were set 1 meter apart. The tea plants, of four varieties, were removed from the nursery and set 2 meters apart in a shallow rich soil, where they are now making a slow growth. From January to April the time was occupied in harvesting the experimental crops, preparing plats for new experiments, and planting same.

In March a special study was made of the brown, or stinging, ant (*Solenopsis geminata*), which was becoming exceedingly injurious in orange orchards in the Bayamon district, where it had destroyed trees to the value of several thousand dollars. The injury is caused by this ant, which is normally predaceous, acquiring the habit of attacking the bark at the base of the trunk and also the bud tips. By gnawing the bark in order to obtain the gummy excretion, which the insect delights to feed upon, sores are made in the trunk of the tree, which are gradually enlarged until the tree is nearly or quite girdled. An ant-killing mixture was devised for destroying the colonies in the ground, and a cheap girdle paint was also prepared to protect the decorticated and gum-exuding areas of the trunk and to prevent the passage of the ants up the tree. This killing mixture has been successfully used, but in some places is replaced by a strong kerosene emulsion. The girdle paint probably saved the lives of many trees by preventing the drying and cracking of the exposed wood.

A budding tape prepared with a certain grade of oilless paraffin from the match factories has proved very successful and costs much less than the ordinary beeswax-resin tape.

## RESULTS OF WORK.

The stock of plants for distribution has been greatly increased with a view of more extensive exchange and gratis insular distribution. Especial attention has been directed toward the collections of bananas, yautias, cassavas, and yams.

Fertilizer experiments have been tried with yautias, cassava, and vegetables only, since the character of the soil in the 10-acre experimental plat is too variable to allow accurate results.

The domestic as well as foreign exchanges have been carefully attended to, with the result that many interesting economic plants have been acquired and distributed at only a slight expense. During the fiscal year over 50 packages of seeds, roots, and plants have been sent to planters on the island, while about 85 packages were received, including some 35 native and budded citrus varieties. Fourteen varieties of plants, including 9 bananas, have been received from the Hawaii Station and 30 varieties have been sent. Over 100 packages have been sent to the States, and about 40 varieties of plants, exclusive of a large collection of grapes from the Bureau of Plant Industry, have been received in exchange. Over 40 varieties of economic plants have been sent to foreign exchanges and about 45 varieties have been received therefrom. The matter of exchanges is rapidly assuming importance, especially with Cuba and the British botanic stations in tropical America.

Perhaps the most important result of work during the year has been the discovery of a parasite (*Chrysocharis livida*) of the coffee leaf miner (*Leucoptera coffeella*). This parasite is doing much toward checking, if not exterminating, the leaf miner in some localities, and measures are being taken for its breeding at the station for distribution to plantations where not found.

The result of hand-picking of the infested leaves, which was begun during the previous fiscal year, was a complete failure, since the number of leaf miners was only slightly reduced in the coffee plat, containing 1,000 trees. Spraying infested plants was likewise found impracticable.

## PLANT COLLECTIONS.

### BANANA PLAT.

Only 6 varieties of bananas are in common cultivation in Porto Rico. To the 23 native and 22 foreign varieties assembled last year there have been added the following varieties:

From Florida, U. S. A.: Golden, Orinoco, Hart's Choice, Cavendishii, and Chue Chumpa.

From Allan's nurseries: One variety, probably Cavendishii.

From Santo Domingo: Johnson.

From Hawaii Experiment Station: Brazilian, Kapua, Hai, Apple, Maole, Hua Moa, Lele, Popoulu, Striped, and Ae-ae.

From Philippine Islands (through U. S. Department of Agriculture, Bureau of Plant Industry): Abacá (*Musa textilis*).

Through insular exchanges: Congo Manila, Maricongo, Niño, Tirabuzon, and Rosa.

From the Canary Islands, one variety, making the present number of named varieties 68.

Nearly all the native varieties and over half of the 22 varieties received from the Jamaica department of agriculture have fruited. Most of the latter have never fruited before in Porto Rico.

A permanent plat in alluvial soil near the office is being planted with five plants of each variety. This plat will be for display, as well as a secondary variety test under very much better conditions than in the old plat, which is still retained for propagating sets for distribution.

Records are being kept of the prominent characters of the stem, leaf, and fruit of each variety. The average weight of the fruit and the percentage of pulp are also ascertained. Experiments in preparing flour, starch, and other products from the different sorts are being carried out with the view of finding varieties which are more palatable in the dried state than those now on the market.

### YAUTIA COLLECTION.

A second variety test is being conducted with the 25 named varieties assembled last year (Pl. XVII, fig. 1), and of these it appears that about five names should be merged as synonyms. The localism of the yautia varieties in Porto Rico is a perplexing problem, which is being gradually worked out. The native varieties are being compared with those from the British West Indies, Guatemala, Belize, and Venezuela. No evidence has been secured of the existence of this valuable crop outside of tropical America previous to the distributions made by this station.

The following varieties have been added to the collection during the past year:

From Arecibo, Porto Rico: Dominica, Vino, Gengibrilla, and Quintal.

From Mayaguez vicinity: Samanal, Isleña, Brava, and Belembe.

From United States, through florists: Two varieties.

From Guatemala: Three varieties.

From Belize, British Honduras: One variety.

From Trinidad Botanic Gardens: Two varieties.

From Cidra, Porto Rico: Amadea, Luquillo, De Rio, Blanca, Martinica, Minas, and Amarilla.

Of the present 46 named varieties about 30 are distinct. At least five botanical species are represented—all of the genus Xanthosoma.

Ripe tubers have been successfully sent to Queensland, Australia, and to Singapore. Very favorable reports have been received from the varieties distributed to the Hawaii Experiment Station.

Analysis of the tubers of variety No. 1 (Rollisa) shows a starch content of 28.65 per cent. The central rhizome, or "madre," of this variety contains about 17.88 per cent of starch, with about 73 per cent of water. The starch grain is of medium size (about 0.01 mm.), and, since there is very little gummy matter, settling is rapid. A sample of this starch, which has been on exhibition in this office for nearly one year, has not deteriorated. It closely resembles cornstarch. There appears to be no reason why the manufacture of yautia, or tanier, starch should not prove very successful.

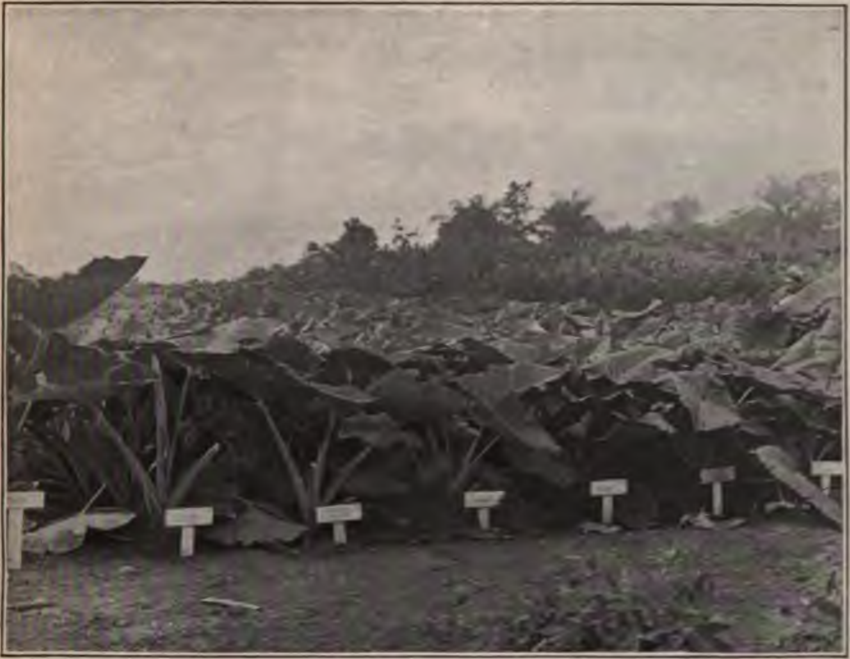

FIG. 1.—YAUTIA VARIETY PLATS, PORTO RICO STATION.

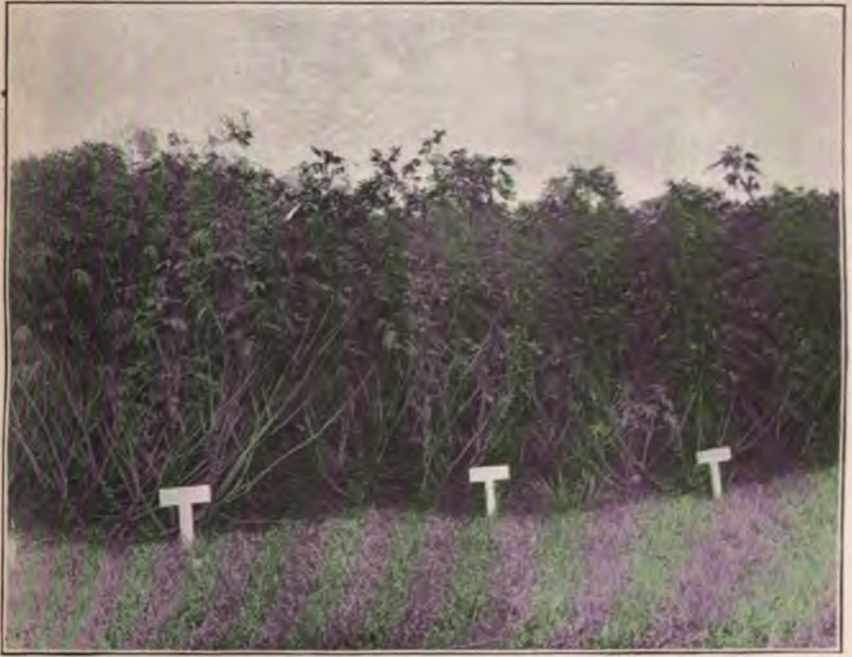

FIG. 2.—CASSAVA VARIETY PLATS, PORTO RICO STATION.

The following table shows the relative proportions of the plant parts of the principal types of the native taniers, or yautias:

*Relative proportion of the plant parts of yautias.*

| Variety. | Weight of entire plant. | Weight of tubers. | Weight of root-stock. | Weight of leaves. | Weight of offsets. | Percentage of tubers. |
|---|---|---|---|---|---|---|
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Per cent.* |
| Rollisa | 11 | 3.75 | 2.25 | 3.5 | 1.5 | 34 |
| Vino | 10.75 | 2.5 | 2 | 4.5 | 1.75 | 23 |
| Martinica | 11.5 | 2.5 | 1.25 | 6 | 1.75 | 22 |
| Amarilla | 15.5 | 1.5 | 2.5 | 7.25 | 4.25 | 10 |

Fertilizer experiments were carried out with plats of variety No. 1; small plats containing 20 square meters, and 50 plants were used. On account of the variable character of the soil and the heavy rains, unsatisfactory results were obtained and therefore the same experiment has been repeated, the results of which will be known about January, 1905. Chemical fertilizers, coffee pulp, stable manure, and guano were tried. The highest yield resulted from the use of about 30 tons of stable manure per acre; this gave edible tubers at the rate of about 16 tons per acre, while one of the check plats gave as low as 8 tons per acre. The highest yield per plant, 3.22 pounds, was in the plat receiving stable manure, while the lowest yield per plant in the check plats was 1.6 pounds.

An experiment was also carried on with a method of double-cropping practiced in Trinidad, British West Indies. By this method a second crop of tubers was obtained from the same plants left standing after the first ripe roots had been removed.

Three diseases of the yautia have been studied. About 15 varieties have flowered.

A bulletin on the yautias, or taniers, of Porto Rico, has been prepared. This is to supply the needed information regarding this exceedingly old, if not the oldest, cultivated crop, which is coming into prominence through at least three of its types as a starch plant and cheap food producer; moreover, on account of the deplorable confusion of the taros (*Colocasia* spp.) and the taniers (*Xanthosoma* spp.) which has continued until the last few years, it is almost impossible to obtain any reliable information regarding the latter crop in any work of reference thus far published.

## CASSAVA COLLECTION.

This collection has been increased by the addition of 2 varieties from the United States, the "narrow-leaf" and the "broad-leaf," 1 variety from Mayaguez vicinity, and 1 from Ponce; 28 named varieties are under test.

A second variety test (Pl. XVII, fig. 2) has been started to complete the data on root characters, yield, stem and leaf colors, and habit, especially with reference to resistance to fungus diseases and the bud maggot. In the first test for quality the average weight of roots per hill ranged from 1 pound (No. 6) to 7½ pounds (No. 17); conditions, however, were very unfavorable.

A test of the six methods of planting is being made, and also a test of fertilizers with the six varieties which gave the best results during the past year.

Four varieties were analyzed for starch content by the Bureau of Chemistry, United States Department of Agriculture, with the following result: No. 1, 23.86 per cent; No. 9, 21.50 per cent; No. 11, 23.84 per cent, and No. 17, 31.69 per cent. Of these all but No. 17 were received from the Jamaica department of agriculture. No. 17, Ceiba, is one of our three best native varieties, being nearly resistant to the bud maggot as well as fungus diseases, and attains a height of 10 feet in ordinary soil.

A small percentage of the roots at cropping were affected at the base with a dry, black rot, and at the tips of a very few of the larger roots was found a form of soft, white rot. A white mycelial growth was noted on some roots. The bud maggot (*Lonchæa chalybea*) has proved very injurious, especially on young plants of the sweet varieties. The principal effect of this pest is to cause excessive branching (which, however, is considered by the natives essential to a good yield).

The other pests mentioned in the Annual Report for 1903 have been but little in evidence this year.

### ORCHARD.

In November 2-year-old budded trees of the following 23 citrus varieties were received from the Allan nurseries, near San Juan: Parson Brown, Ruby, Jaffa, Mandarin, King, Dancy, Tangarine, Satsuma, Dulcissimo, Bessie, Enterprise Seedless, Hart Late, Majorca, Homosasa, Magnum Bonum, St. Michael Blood, Pineapple, Valencia Late, Washington Naval, Thompson Naval, Duncan Pomelo, Marsh Seedless Pomelo, Kumquat (2 varieties), and Lemon.

In December and again in February buds of the following varieties were received from Florida: Oneco, Tresca, Centennial, Foster, Early Oblong, Royal pomelo, Pernambuco pomelo, Genoa lemon, Corsica citron, and Sour Rangpur lime. These buds were set in both rough-lemon and sour-orange stock. About 20 varieties of native seedling oranges and grape fruits have been secured and budded into our nurseries.

Plants of *Citrus trifoliata* for stock were secured, both from Aguadilla, Porto Rico, and Florida, United States of America. A good quantity of seedlings of sour orange, bitter-sweet orange, and native grape fruit have been raised for budding purposes. A few seedlings of a sweet native grape fruit have been grown. In all, about 60 citrus varieties are now growing in orchards and nurseries.

The following varieties of fruits and nuts have been added to the 70 varieties listed in the report for 1903:

From Florida: Guavas (3 varieties), Akee (*Cupania sapida*), Avocado pear (Black Mexican), *Phyllanthus emblica*, *Hovenia dulcis*, *Rheedia edulis*, and Mango (Black Jamaican).

From Atlanta, Ga.: *Asimina triloba*.

From Aguadilla, Porto Rico: Murta (*Eugenia* sp.).

From Plant Improvement Gardens, Santa Ana, Cal.: *Castanea vesca*, *Juglans regia*, *Juglans californica*, and *Juglans sieboldiana*.

Sugar palms (*Arenga saccharifera*) from seed received through the Bureau of Plant Industry, from Manila, P. I., have been set out.

From Bureau of Plant Industry: One collection grafted mangoes and one collection Mangosteen seedlings.

### MISCELLANEOUS CROPS.

The following plants have been added to the collection:

From Arecibo: Jamaica sorrel (*Hibiscus sabdariffa*); Vegetable musk (*H. abelmoschus*).

From the United States: Jerusalem artichoke (*Helianthus tuberosus*).

From Hawaii: Japanese taro, Royal taro, one yam, and *Macadamia ternifolia*.

From Porto Rico: Apio (*Arracacia esculenta*), Granadillo (*Passiflora quadrangularis*), one variety melon, one variety tuna (*Opuntia* sp.), *Cereus triangularis*, and vegetables, several native varieties.

The "Panamá," or wild *Alocasia macrorhiza*, has been grown in comparison with a variety obtained in Caracas and is apparently superior to the latter, producing roots of 10 to 15 pounds weight in about twelve months. These roots are used for feeding swine.

Two packages of "Dasheen" (*Colocasia* sp.) from Trinidad, British West Indies, have proved nearly identical with the variety tested last year. Contrary to expectation this plant has proved very different and, in many respects, superior to our native "malanga" (*Colocasia antiquorum esculentum*); it produces tuberous offsets of a high quality, and in about six to eight months from time of planting the first tubers are ready for harvesting. Two to four pounds of roots per hill are produced in good soil, and some 10,000 to 15,000 plants may be set per acre.

The native Yam Bean (*Pachyrhizus tuberosus*) has exceeded expectations. Numerous roots weighing as high as 5 and even 7 pounds each were obtained without the use of fertilizer. Analysis shows the starch content to be nearly 15 per cent, with over 75 per cent of water; the cellulose is proportionately low and commercial starch extraction should be simple. A fertilized plat has been planted with this interesting crop. Seeds have been distributed to various localities of the island and to the foreign exchanges. It occurs wild in the virgin forest at the coffee substation.

The Teyote (*Sechium edule*) has proved a failure at the station grounds; two varieties were found, however, growing luxuriantly in the virgin forest at the coffee substation. It apparently requires rich soil, partial shade, and considerable moisture.

The *Centrosema plumieri*, brought from St. Vincent, has proved a valuable cover crop. Since it roots at the joints, one plant will quickly cover several hundred square feet, and as it lives for two seasons at least, it is hoped it will prove valuable in orchards having sandy soil.

The Venezuelan Apio (*Arracacia esculenta*) is thriving in a moist, partly shaded location. This important vegetable is grown to some slight extent in the interior districts.

The Costa Rican papaws have proved inferior to the native varieties in point of richness of flavor.

The two roots received from Hawaii Station as *Tacca pinnatifida* have continued to make an exceedingly heavy and healthy growth, but it is now evident that they belong to the genus Dioscorea (and are probably *D. pentaphylla*).

The native "malanga" (*Colocasia antiquorum esculentum*) has made a very strong, healthy growth. Analysis by the Bureau of Chemistry, U. S. Department of Agriculture, shows the mature roots to contain 14.94 per cent starch and 74.47 per cent moisture. But since the starch grain of this root is so very small and the gum content so high, extraction of the starch commercially would be quite difficult.

The two varieties of Hawaiian taro (*Colocasia* spp.) resemble in habit and flower the Trinidad varieties called "Dasheen," but the yields are much less. They appear to be free from the Hawaiian root disease thus far.

The edible canna (*Canna edulis*) has continued to make a good growth, and has remained almost free from attacks of either fungus or insect parasites. The yield was about 15 tons of roots per acre, the same as was obtained at Rio Piedras. These roots show a starch content of 19.41 per cent and 70.25 per cent water. The starch grain is very large and readily separable. Although this crop requires a moist, rich soil, it is quite possible that it may become an important starch producer of the future.

*Coffea stenophylla*, *C. robusta*, *C. liberica*, and some six varieties of

*C. arabica* have been received through the foreign exchanges and turned over to Mr. J. W. van Leenhoff, at the coffee substation.

### FIBER PLANTS.

Bulbils of *Furcræa fœtida* have been received from Mauritius Island through the Bureau of Plant Industry. They have been planted out near the native variety in order to prove the supposed identity therewith. One plant of *Furcræa tuberosa*, from Central America, has been received.

Plants of the native maguey (*Furcræa fœtida*), which are now eighteen months old from the bulbil, have leaves 5 feet long, and are growing rapidly. The 2-year-old Bahama sisal plants have 3-foot leaves.

The Bahama sisal (*Agave rigida sisalina*) has made a fairly good growth and is now free from the bacterial disease with which it was affected during the previous year. Numerous offsets have been set out ready for distribution.

Twelve bulbils of a plant believed to be the true *Agave rigida* have been received from Sneads Island, Florida.

Seeds of *Bœhmeria nivea* have been received from the Bureau of Plant Industry.

*Sansevieria zeylanica* has been added to the collection.

*Gossypium arboreum*, from Mexico, is making a slow growth.

A plat of mixed cotton has done well. Several varieties are now being planted for a comparative test.

Specimens of ropes and cordage, prepared from various native plants at the coffee substation, have been secured for exhibition at the station office.

### FOREST PLAT.

The following species have been added to the nurseries for this plat:

From Cabo Rojo, Beefwood (*Casuarina equisitefolia*). From Ponce, Rain-tree (*Pithecolobium saman*). From British Honduras, Broad-leaf Mahogany (*Swietenia macrophylla*). Through Bureau of Plant Industry, Chinese oil-nut (*Aleurites cordata*); Chinese oak (*Quercus cornea*); sugar palm (*Arenga saccharifera*); Talipot palm (*Corypha umbraculifera*).

From Curacao: "Cuji" and Divi-Divi (*Cæsalpinia coriaria*).

From British West India stations: "Madre de Cacao" (*Gliricidia maculata*), *Bauhinia* sp., and *Parkia africana*.

Through the United States Department of Agriculture, Bureau of Forestry: Hybrid *Eucalyptus* and *Grevillea robusta*.

From Plant Improvement Gardens, Santa Ana, Cal.: *Parkia roxburghii*.

Nearly all the varieties set out in 1902 are now making a fair growth; the *Eucalyptus* spp. especially have done very well, considering the exceedingly poor soil of the plat.

About 75 species of timber trees are under trial in this plantation; 100 square feet are allowed each tree.

## INSECT PESTS.

The cotton stainer, *Dysdercus suturellus*, has caused considerable damage in a cotton field near Sabana Grande. *Aphis gossypii* has been reported from only one locality as a serious pest, but it undoubtedly occurs throughout the island. The coffee aphid occurs over a wide area, if not the entire interior of the island, but does no damage except to the tender shoots in overshaded localities. The malanga, or taro, aphid has been much less in evidence than during the previous year. *Pteromalus calandræ* in a common parasite of the rice weevil (*Calandra oryzæ*) at the station.

During the past year no complaint of the changa (*Scapteriscus didactylus*) has been received at this office. The grass Paris-green bait remedy, recommended in Bulletin No. 2 of the station, is being successfully used, not only in Porto Rico, but also in the British West Indies. The bug maggot (*Lonchæa chalybea*) of the cassava has continued a serious pest in the tips of cassava canes. Hand picking is the best remedy, though tobacco dust applied to the buds is effective in the dry season. The cassava tingitid (*Atheas nigricornis*) has been less destructive on cassava leaves than in the previous year.

The black-winged white ant (*Eutermes morio*) has been practically exterminated in the vicinity of the station buildings; burning with kerosene was found the most reliable method.

The striped weevil (*Exophthalmus spengleri*) continues in abundance in orange orchards throughout the island. Hand picking is commonly practiced, but merely serves to keep the pest in check. This weevil and a smaller species, closely related, are common in some coffee plantations where they do considerable injury to the buds and young leaves.

The tobacco leaf miner (*Gelechia picipellis*) did some slight damage in the experiment plats at Aguas Buenas.

Four species of Lamellicorn beetles attacked citrus and banana leaves on the north side of the island, doing more or less injury during the dry season. Hand collecting at night and the use of lime on the ground about the trunk appear successful in the Bayamon district. These beetles make numerous vertical burrows close to the base of the trunk and hide in these burrows during the daytime. It is thought that the larval stage is passed among the orange roots, though this has not yet been definitely proven.

It is estimated that the Tineid coffee leaf miner (*Leucoptera coffeella*), by checking the growth and destroying the leaf tissue of coffee plants throughout the island, resulted in from 5 to 10 per cent loss of last year's coffee crop. This would amount to from $150,000 to $300,000, taking into consideration merely the product of berries and not allowing for the damage to the vigor of the plant. Experiments in collecting by hand infested leaves from a certain number of isolated trees proved an entire failure; likewise spraying experiments have thus far proved ineffective in checking the ravages of this pest.

The coffee leaf miner, however, is on the decrease in several districts of the island, due very largely to the attack of a Chalcidid parasite (*Chrysocharis livida*) found in the coffee plats in the station grounds. The life history of this very beneficial insect is nearly worked out, but its method of oviposition is unknown. Larvæ of the parasite, however, have been found inside the bodies of Leucoptera larvæ, and it is believed that the egg is laid in or upon the half-grown larva of the leaf miner. On account of the numerous immature larvæ of the parasite found in empty burrows of the leaf miner, it appears that because of the abundance of the parasites the female frequently oviposits in larvæ that are too young to allow the complete development of the parasite, and that the parasitic larva, after having devoured its too small host, is left without food and probably dies in the burrow without reaching the pupal stage. Attempts to induce these starving parasites to feed upon Leucoptera larvæ have in all cases proved unsuccessful, even when the parasite has been partially introduced into the host larva. The full-sized larva of the parasite is about one-third the size of the host larva—that is, a little more than 1 millimeter in length. The pupal stage is normally passed inside the burrow of the leaf miner; the shining bluish black pupa is loosely attached by its posterior extremity to either the wall of the burrow or to the integument of the consumed host; one pupa was found in a cocoon of the host larva on the outside of the leaf. The imago is black with purplish reflections from the thorax; the size is about 1 millimeter; it is very active, and lives two to four days in captivity. It is doubtful whether living specimens of this parasite could be sent successfully to other islands in the West Indies where the leaf miner is a serious pest, unless, perhaps, in a Wardian case with its host, under more or less natural conditions.

## FUNGOUS DISEASES.

*Ascochyta nicotianæ*, under two or three forms, caused considerable injury to the station's tobacco plats at Aguas Buenas.

A fungus belonging to the Sphæropsideæ has been very prevalent on banana leaves, causing minute clustered dots, beginning on the under side and extending through to the upper surface, associated with a yellowing of the surrounding area. This attack usually precedes a gradual wilting of all the leaves of the plant, but may continue for months in an immature state. A rot, probably of bacterial origin, did considerable injury to bananas fertilized with nitrogenous manures; streaks of brownish tissue indicate the course of the disease from the root bulb to the top of the pseudostem. Destroying the affected plants apparently checks the trouble, though the suckers from the old bulb grow slowly.

The tomato wilt, which has been under investigation for over two years, has not yet been definitely determined, but it certainly resembles very closely in effect the *Bacillus solanacearum*. It appears to be common in the West Indies and prevents the successful cultivation of tomatoes in this region. Plants at the coffee substation, at about 1,000 feet elevation, showed only slight traces of the disease.

The American coffee disease (*Stilbum flavidum*) occurs very rarely.

A yellow-spot fungus, in effect resembling *Stilbum flavidum*, occurs on "rough lemon" leaves, and may become a serious pest in orange nurseries.

White mycelial growths have been noted on the roots of cassava, yautia, yam, and coffee. In the case of coffee this fungus was usually accompanied by more or less decay of the interior of the root. This mycelial disease of the yautia root seems to be distinct from *Peronospora trichotoma* of the taro.

A serious disease, called locally "el mal," attacks the fibro-vascular bundles of the rhizome of yautias, especially of *Xanthosoma sagittæfolia*, beginning at the tip and slowly spreading into the tubers and upward through the root stalk, finally causing the decay of the latter, and occasionally reaching the leaf bases. This fungous or bacterial disease apparently does not affect the vitality of the tubers when left in situ.

A peculiar leaf disease of the yautia occurs on the older leaves, causing roundish or somewhat irregular brownish patches, showing concentric rings of a darker shade; it is much more prevalent in the dry season. Samples of this fungus were determined as *Periconia pycnospora;* a *Glœosporium* sp. was also found in a sample sent for determination to the Bureau of Plant Industry.

A black-spored fungus occurring in roundish patches on the leaves of *Canna edulis* was determined as *Periconia* sp. The roots of *Canna edulis* appear completely resistant to all fungi.

*Cladosporium citri* continues to be a serious pest in citrus nurseries, on sour orange seedlings used for budding stock; it severely checks the growth of these seedlings so that the orange planter is compelled to insert the sweet orange buds as early as possible—frequently when the stock is under 2 feet in height.

A disease apparently fungous in nature is becoming generally prevalent on the coffee leaf miner (*Leucoptera coffeella*) in its early larval stages. Cultures have been made with this material, but in only one case did a white mycelial growth indicate the fungous nature of this disease. The etiology of this very important disease of the most serious pest of Porto Rican coffee demands careful investigation. In the coffee plats at the station grounds about 30 per cent of the leaf miner larvæ are found dead in their burrows; at the coffee substation about 10 per cent, on an average, of dead larvæ are found.

The fungus, provisionally determined as a Sporotrichum by Prof. F. S. Earle, continues to be very plentiful on the red scale (*Lecanium hemisphæricum*) throughout the island, and it aids very largely in keeping this pest in check. Inoculation experiments have not proved successful thus far, probably on account of the sensitiveness of this fungus to a dry atmosphere.

The coffee leaf blight discovered in June, 1903, by Prof. F. S. Earle, and provisionally referred by him to the genus Sclerotium, is abundant in many districts in the west part of the island. In April, 1904, this disease was carefully studied at the station coffee plats by Dr. G. P. Clinton. This peculiar disease appears to attack the root system first, causing more or less decay therein, and thence ascends the trunk in the form of brownish or black mycelial threads. Upon these threads reaching the base of a leaf they begin to spread and frequently appear like a thick mass of cobweb. The base of the leaf at once turns dark brown, though the midrib and distal portion may remain green for some time. Upon the death of the leaf the petiole breaks away from the branch, but is held by the tough strands of the mycelium.

Specimens of a rare coffee leaf disease occurring in the vicinity of Arecibo have been determined as a *Sphæropsis* sp.

## REPORT OF H. C. HENRICKSEN, ASSISTANT HORTICULTURIST.

The writer entered on duty at this station March 1 and took charge of the following lines of work, which were outlined in last year's report: Citrus fruits, pineapples, vegetables, cacao, miscellaneous fruit orchard, tea, and rubber.

The scope of work with all of these has been considerably broadened, and the following new experiments have been started: Grapes, mangoes, aguacates, and the propagation of miscellaneous tropical fruits.

## CITRUS FRUITS.

The nursery contains about 3,000 trees, consisting of rough lemon and sour orange, with a few sweet and bitter-sweet oranges, as well as some pomeloes, limes, and sweet lemons. One lot of these were planted in the seed bed December, 1902, and transplanted into the nursery June, 1903. The trees not budded are now 7 to 8 feet high and are rapidly outgrowing their usefulness as budding stock. Another lot was transplanted June, 1904, and will be ready for budding this fall. Two weeks before the writer's arrival 114 trees were budded to 11 varieties introduced from Florida. Since then 176 trees have been budded to 16 varieties, of which most were selected from seedling trees on the island.

The citrus grove contains about 250 budded trees, consisting of 22 of the best named varieties of orange, pomelo, and lemon, as well as a few selected seedlings and a number of stock ready for budding. (Pl. XVIII, figs. 1 and 2.)

A bulletin on The Propagation and Marketing of Citrus Fruits in Porto Rico has been issued.

The work for the ensuing year will be to collect bud wood from the best native seedling trees and bud one or two dozen nursery stock with each variety. When large enough, five trees of each of these will be transplanted into the orchard and the rest distributed among the growers.

The grove will be cultivated and fertilized, and notes carefully kept in order to form an idea of the cost of orange growing in this locality. Different legumes will also be tried as soiling crops.

### THE OUTLOOK FOR CITRUS CULTURE IN PORTO RICO.

Citrus fruits are not cultivated extensively except around San Juan and a few places between there and Arecibo, which may be attributed to three things—the proximity to San Juan, where all the steamers from the States land; the character of the soil, which closely resembles the Florida soil, and the fact that the pioneer nurserymen settled there. It could not be because of the natural fitness, as nearly all of the oranges exported come from the west end of the island, and it is admitted by the growers that there is a vast amount of land there which is as well fitted for oranges as that of the San Juan district.

The writer recently visited most of the groves at Bayamon and Rio Piedras and noted the following facts: Most of the groves are from 25 to 500 acres, none is over four years old, most of the grove managers are practical Florida men, and Florida methods are used.

Neither foot rot nor die back nor wither tip was noted, and neither

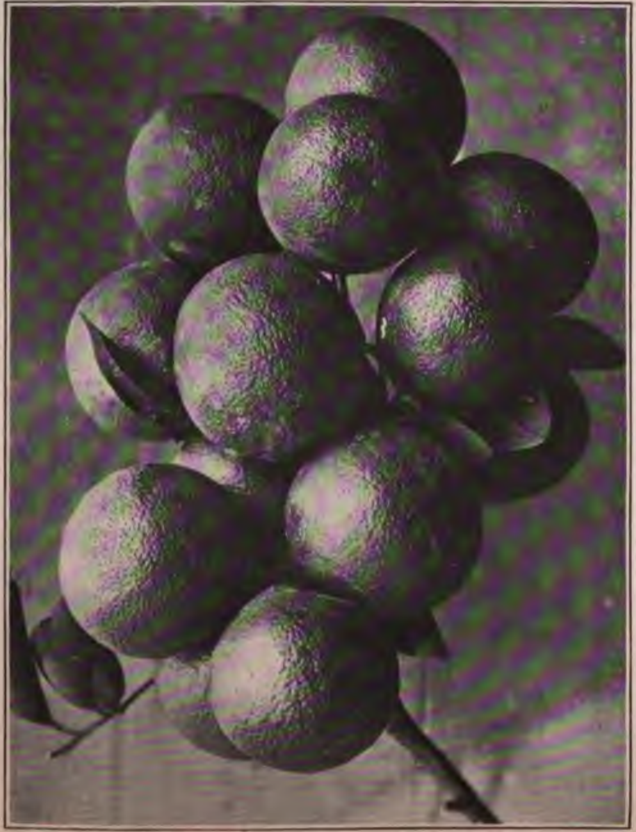

FIG. 1.—A PORTO RICO SEEDLING ORANGE.

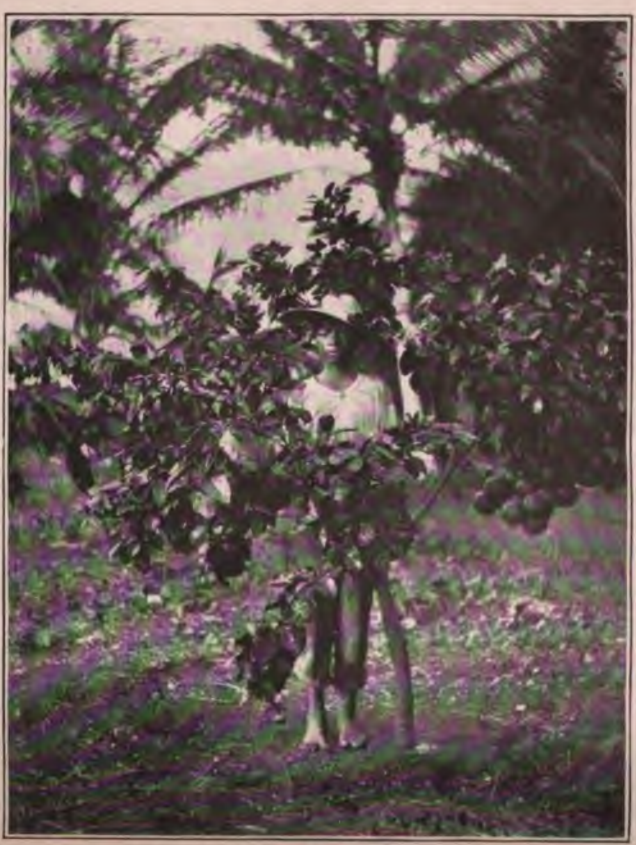

FIG. 2.—A BUDDED POMELO TWO AND ONE-HALF YEARS AFTER PLANTING.

has been reported. As there are no budded trees over four years old, it would be rather early to look for blight, but as none has been noted in the old seedling groves it should not be anticipated. With all of the foregoing, as well as the white fly eliminated, the Florida grower ought to feel contented in Porto Rico. But every place has its drawbacks, and here it has so far been the purple scale (*Mytilaspis citricola*), which at present is doing enough damage to make up for the absence of all the rest. Some growers are spraying and feel disheartened because a few applications do not exterminate the scale. Others have gone to the extreme of cleaning the trees by hand, and still others have done nothing whatever.

In the groves where spraying has been followed persistently and intelligently the scale is kept within bounds, and no grower has reason for dissatisfaction when remembering that this pest has been fought in Florida and California nearly fifty years and is still at large.

In the groves cleaned by hand the trees were healthy when planted and are kept so by constant attention. As soon as the scale is noticed a careful man is detailed to look after that part of the work, and the trees are gone over every two weeks and all the scale that can be found is picked off with a knife blade or a small stick. This method is very successful while the trees are small, and is probably no more expensive than spraying.

The groves that have not been treated for scale are all dead or dying, with the exception of one that is located in a hummock not unlike the Indian River and Orange Bend hummocks in Florida. Here strips of natural growth are left all through the grove, as well as a great number of palms scattered among the orange trees. These trees provide both wind and protection and shade, and the air is humid and the temperature fairly uniform. This grove is four years old, it covers over 400 acres, and is without exception the best budded grove on the island. It is not free from scale, but the scale is heavily parasitized, and the conditions are favorable enough for the parasites to keep it in check. This has also been observed in other places where the natural conditions had not been interfered with and is well worth considering when locating a grove.

While the above gives a good illustration of the advantage of favorable conditions, a careful observer would not fail to note that real success has been attained only by the men who have devoted their whole attention to the subject. The old adage that "an ounce of prevention is better than a pound of cure" ought to be thoroughly memorized by every orange grower, and every mistake by others as well as his own should be put down as a "don't." Here are some that may head the column: Don't neglect to prepare your land before planting. Don't plant scaly or sickly trees. Don't let your trees stand still, work and fertilize them in order to keep them growing. Don't leave a sickly tree; if it will not grow pull it up and plant another; in the plant world as well as the animal world there are a few individuals constitutionally weak—destroy them, it improves the race. Don't let a destructive enemy like scale get a foothold, but attend to individual cases in the beginning, as one infected tree will infect the whole grove. Don't leave everything to the inexperienced workman—you can not expect both brain and muscle for 40 cents a day.

The seedling trees in the many natural groves around Mayaguez are very healthy and bear a comparatively good grade of fruit. Most of the trees are nearly thornless, which is unusual for seedling trees. There are no budded groves on this end of the island over one year old, but in the few instances noted the trees are doing well.

As there is a vast amount of land on the island which is no doubt as well fitted for citrus culture as the groves already planted, and remembering that the export last year amounted to over 130,000 boxes, which was probably not more than half of the actual production, it will readily be seen that Porto Rico will soon have to be reckoned as one of the chief citrus-producing countries.

## PINEAPPLES.

There are four varieties of pines commonly grown on the island, viz, Porto Rico, here called Cabezona; Sugar Loaf, here called Pan de Azucar; a dark-leaved plant here called Negrita or Mamey, and a small, dark-green, very spiney plant here called Caraqueña. None of these has so far been of commercial importance except the Cabezona. This is extensively planted 5 miles west of Lajas, where the formation is rocky, with hills ranging from 50 to 200 feet higher than the surrounding plain. (Pl. XIX, fig. 1.) The soil is a heavy loam, mixed with coarse broken rock. The plants are set 8 to 10 inches apart in rows 6 to 8 feet apart, running around the hill. Paths leading from the bottom to the summit are left at intervals, by which the fruit is brought down in baskets, which the natives carry on their heads, though the slopes are often very steep. The fruit varies in size from 3 to 25 pounds; most weigh over 5 pounds and few over 20 pounds. This year about 140,000 fruits were shipped by rail to Mayaguez and canned for export. (Pl. XIX, fig. 2.)

The pinery on the station grounds now contains 17 varieties and more are expected soon. The Cabezona has been planted extensively in order to show different methods of planting and to conduct fertilizer experiments, as well as some other experiments outlined, if time will permit.

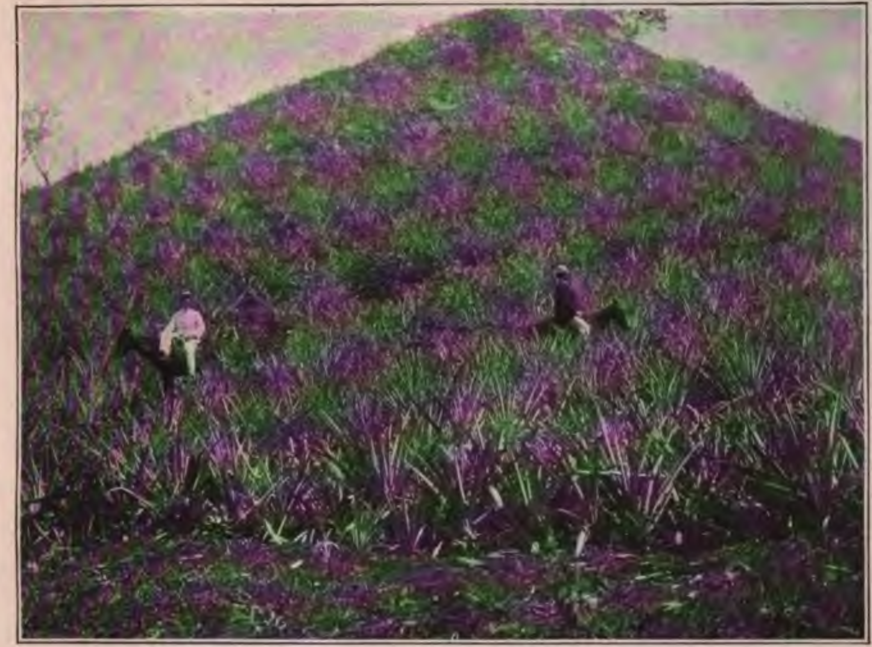

FIG. 1.—MOUNTAIN SIDE PLANTED TO PINEAPPLES, PORTO RICO.

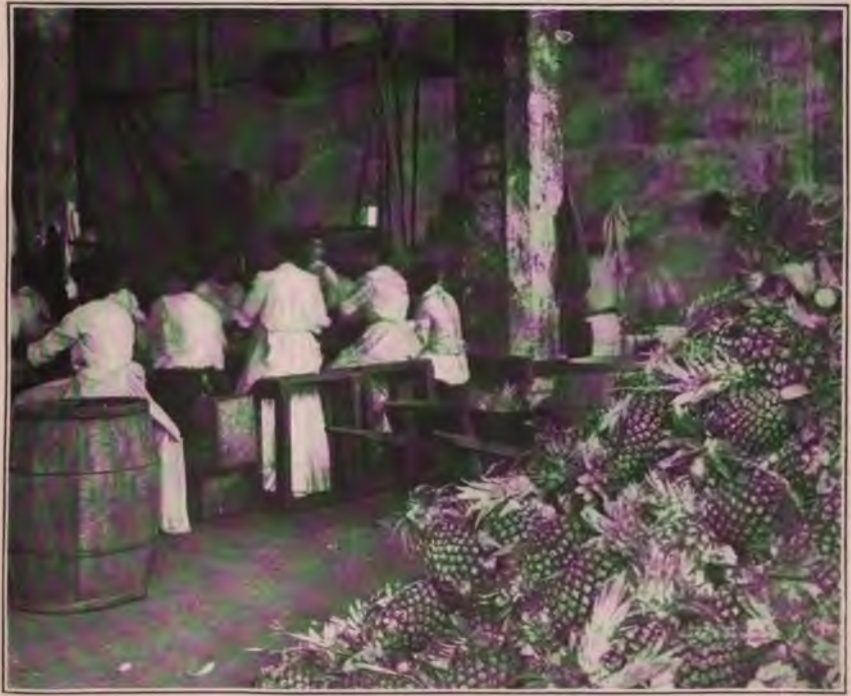

FIG. 2.—CANNING PINEAPPLES, MAYAGUEZ.

Some experiments were started in May in cooperation with the owner, F. I. Matthews, at Rincon, whose pinery is located near the ocean, in a soil consisting of a coral sand. The plants there suffer from some physiological derangement not met with in Florida.

## VEGETABLES.

The last week in May 56 varieties, comprising 21 species of vegetable seeds, were planted. This, with slight variation, was repeated in June and will be repeated every 30 to 60 days until next spring. Of tomatoes 104 varieties have been planted in order to find, if possible, some that are resistant to blight and wilt. Extensive experiments with grafting tomatoes and eggplants on the different varieties of Solanum have also been started. Native vegetables and herbs will be grown and improved by selection.

## CACAO.

A valley on the station grounds was planted in June, 1903, with 350 cacao seedlings, comprising 12 varieties. Of these 314 are alive and growing vigorously. No cultivation is done except hoeing around the trees, and on the hillside drawing the soil from above to below the trees, making a level place a few feet wide around each. The natural growth has been gradually cut out and cuttings of *Erythrina mycropteryx* and *Gliricidia maculata* have been planted in rows between the cacao. Some of these have made a growth of 10 feet in six months, but the majority do not root as easily as anticipated. Some work in propagation of cacao has been outlined for the coming year.

## MISCELLANEOUS FRUIT ORCHARD.

At the beginning of March this orchard contained 224 plants, comprising 81 species and varieties of native and imported trees and shrubs. Only a few plants have been added this summer, but a number of species will be planted next November and the experiments will be entirely confined to fruit-bearing plants of economic value. In a collection of this kind each species and often each variety should receive individual attention, which, however, will be almost impossible with the present means at hand.

## TEA.

The plat planted with tea contains the following varieties: Japanese, Anam, Dragons Pool, and Amoy. It was planted July, 1903, in some of the best soil on the station grounds, and the plants grew well and were well cared for, but they soon threw out a profusion of bloom, which was constantly removed under the botanist's direction.

March 1 the bushes averaged about 18 inches high and were very compactly branched. They were full of bloom, which was removed. About a month later, when again blooming, the bushes were heavily trimmed and a commercial fertilizer containing an excess of ammonia was applied. This, however, has not changed the behavior of the plants, as they are about the same size to-day. Plants of three of the varieties have been sent to the coffee station in the mountains.

### RUBBER.

The following extracts are from notes made by the botanist of the station: January, 1903, 100 yearling seedlings of *Castilloa elastica* received from the United States Department of Agriculture were planted in nursery beds. In August these plants were transplanted into the permanent rubber grove situated in a valley on the station grounds. The ground, which bore signs of former cultivation, was overgrown with long grass, which was cut around the holes only. The holes were dug 1 foot deep, 14 feet apart each way, and top soil filled in around the roots. June, 1903, seeds of Castilloa were received from Costa Rica. These germinated well and grew rapidly and 100 were transplanted to the rubber grove in August, while 100 more were transplanted to a nursery from which distributions are being made. Seedlings of *Funtumea elastica* and cuttings of *Ficus populnea* were also planted. Since March 1 all the plants have been hoed three times and the circle gradually enlarged around the trees by cutting the grass, which has been applied as a mulch, and in May some of the trees were fertilized with one-half pound nitrate of soda to each tree. The trees now measure from 10 inches to 6 feet high and are looking healthy, but about a month ago they were yellow in color and showed the effect of the dry weather. The fertilized plat shows no increase in growth over the unfertilized, but in the bottom of the valley, where the soil is better and moister, the plants are much larger and thriftier than on the dry hillside. Some of the distributed trees are reported as doing well, but from present indications Castilloa should be planted only in rich moist soil.

### GRAPES.

A number of grape cuttings received from the Bureau of Plant Industry of the U. S. Department of Agriculture were planted in a piece of ground wholly unfit for a cutting bed, but nothing else was available at the time. Many of the cuttings failed to root and the others made but slow progress. The most promising of the rooted cuttings were later transplanted to the permanent vineyard, which was located on a typical dry hillside having a tenacious red clay soil. This site was chosen on account of being accessible to an irrigation ditch.

Grapevines are found scatteringly on the island, but are not grown commercially, which is said to be on account of the fact that the culture of grapes was prohibited under the Spanish rule.

As grapes are grown on other West Indian islands, the work which naturally suggests itself would be to select and plant such varieties as those succeeding under conditions similar to Porto Rico. However, the location of the experiment station is not one that would naturally be selected for a vineyard, and, if the means would allow, further experiments should be carried on at a higher altitude.

### MANGOES.

The most promising fruit tree in the vicinity of Mayaguez is without exception the mango. The trees are conspicuous everywhere with their dark-green and wine-colored foliage. They are never cultivated, but may be found in waste places, and especially in old fence rows, where they were planted years ago as wind-breaks. Such valuable trees would be considered an asset nearly everywhere, but here their greatest value is in the amount of firewood they produce, the top being cut off every other year and used for fuel. This treatment does not seem to injure the trees, as a new top will be formed in a short time, but, of course, not much fruit is produced. The fruit is good, bad, or indifferent—mostly the last—but it might be safely stated that not many trees bear fruit of exactly the same quality, and there will, of course, never be demand enough for it to justify shipping. But if it can be demonstrated that these trees can be grafted or top budded they will be a source of income never dreamed of. Some experiments in that line have already been conducted, which will be continued until satisfactory results shall have been obtained. Twelve of the best varieties growing in India have been received as grafted plants from the U. S. Department of Agriculture. These have been inarched into large trees and may be expected to bear fruit in two years.

### AGUACATES.

Like the mango, this fruit ought to be propagated asexually, as it does not come true to seed. It grows vigorously all over the island and a great amount of magnificent fruit is produced, which ought to be shipped to the States as it is fully equal to the Florida product, though it may be difficult to ship with the present facilities. But after a few years' selection and cultivation and with improved shipping facilities the aguacate will undoubtedly be one of the best paying fruits on the island. The initiatory steps have been taken toward propagating this fruit on a large scale and the coming year's work will include selection of the best varieties on the island as well as from abroad, which, when budded, will be distributed to the growers.

### PROPAGATION OF MISCELLANEOUS TROPICAL FRUITS.

The ten foregoing subjects have been taken up first, not by any means because they are the most important, but because they come nearest to hand. The fact is that the Tropics possess so many unsolved horticultural problems that one is more likely to undertake too much than not enough, but it is much to be deplored that the propagation of a delicious fruit like the Ceriman (*Monstera deliciosa*) should be neglected just for the want of a few hours' time, or that the propagation of the fruit of all fruits, the mangosteen, should be delayed for another year simply for the want of a little more money. A hundred small seedlings of this tree were recently received from the U. S. Department of Agriculture, but unless time can be spared to bud, graft, or inarch it onto some allied species, of which there are some growing wild on the island, it will be many years before Porto Rico will produce mangosteens, and, in fact, it may never do so, as the tree may not succeed on its own roots in the Porto Rican soil.

The guava grows wild in Porto Rico—in fact it is a weed and is met with everywhere. In spite of this, the writer has not been able to obtain a fruit which a Floridian would call edible. Here is room for improvement.

The *Spondias dulcis*, a tree bearing a fruit nearly as large as an apple and of fine flavor, grows on the island, but is not very common because it is extremely difficult to propagate. If it could be grafted on hog plum, or Jobo (*Spondias lutea*), one of the most common trees of the island, or even on the Spanish plum (*Spondias purpurea*) it would be worth a great many thousand dollars to the island.

Many more of equal importance might be added.

## REPORT OF J. W. VAN LEENHOFF, COFFEE SPECIALIST.

This year has been one of exceptional climatic conditions. The wet season, which as a rule ends about the middle of January, continued all through the months of February to April, and an especially heavy rainfall occurred during March. In consequence the blossoming of coffee, which occurs during these months, has been irregular, small, and damaged. It is estimated that the coffee crop will be only about from one-third to one-half of last year's crop.

Oranges, mangoes, and all other fruits have suffered even more, and minor fruits have in most cases given very poor results. As various other districts report similar conditions, it can be said that the whole interior of the island has suffered a crop failure.

The influence of the conditions upon our experiments has been that we can not show results of our work. Experiments with fertilizers do not show any returns in larger quantities of berries, but only in a more luxurious foliage and the general finer condition of the trees. The same can be said of all other experiments made with the view of increasing the production per tree.

## IMPROVEMENT OF OLD COFFEE GROVE.

The crop produced on each of the 10 acres was again ascertained. Besides, all the productive trees thereon were counted in order to make it possible to get at the figures of production per tree. The results, as shown by the crop of 1903, are given below.

*Yield of coffee on experimental tract in 1903.*

| | Acre No.— | | | | | | | | | | Total. | Average per acre. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8.[a] | 9. | 10. | | |
| Ripe berries: | | | | | | | | | | | | |
| In liters | 923¼ | 805 | 943½ | 1,418 | 224 | 311½ | 418 | .... | 521 | 520 | 6,084¼ | 676 |
| In pounds | 1,229 | 1,009 | 1,191½ | 1,985½ | 325 | 381 | 487½ | .... | 708 | 669 | 7,985½ | 887 |
| Coffee ready for market, in pounds | 251 | 206 | 243 | 397 | 67 | 78 | 101 | .... | 144 | 136 | 1,623 | 180⅓ |
| Productive trees per acre | 413 | 1,095 | 882 | 742 | 428 | 745 | 584 | .... | 902 | 924 | 6,715 | [b] 746 |
| Product per tree, in pounds | 0.608 | 0.188 | 0.275 | 0.535 | 0.156 | 0.105 | 0.173 | .... | 0.160 | 0.147 | ....... | 0.261 |

[a] All coffee trees taken out and partly replanted.

[b] Average per tree.

The same figures of the cost of production as last year were used, except the price of pulping, hulling, and drying, which was increased from 60 cents to 75 cents per 100 pounds, making the cost per 100 pounds for harvesting and marketing the coffee as follows:

| | |
|---|---|
| Picking | $1.16 |
| Pulping, hulling, and drying | .75 |
| Transporting berries from field to factory | .10 |
| Transporting to Ponce market | .25 |
| Total per 100 pounds | 2.26 |

After the harvesting the whole of the 10 acres was again carefully weeded and the trees pruned. The pruning consisted in the removal of all dead wood, the cutting down of all stumps that had lost their branches, excepting a few at the top, and the removal of all suckers. In some cases where stumps had lost many branches, but not sufficient to as yet cut them down, one or more suckers were allowed to remain so as to produce new stumps for the time when the old ones should be cut down.

The planting of leguminous plants between the coffee gave very good results as far as these plants themselves were concerned. After attaining maturity they were hoed under, but results to the coffee could not be obtained for the same reason as given for the fertilizers.

### CUTTING COFFEE TREES TO STUMPS.

The trees in plats 9 and 10 cut to stump last year are doing well, in so far as they are not suffering from the attack of the leaf miner. The two shoots allowed to remain on each stump have now developed into trees about 6 feet high, which promise to be in bearing next year.

### RENOVATING OLD COFFEE PLANTATION.

Plat No. 13 was found to consist of a thin layer of soil on top of rock, for which reason it was found not possible to cultivate it, and accordingly it was abandoned.

Plat No. 14 was planted with 164 coffee seedlings from nursery beds and 38 guaba seedlings for shade. All were cut on stump to 6 inches above the root collar, and are now doing very well.

Plat No. 15 was planted to alfalfa with the intention of using this as green manure by plowing it under, and then to plant coffee. The alfalfa, however, looked so promising that it was decided to allow it to stand, to reseed where necessary, and to continue experimenting with it in the hope that it might prove a valuable acquisition to the agricultural resources of the island of Porto Rico.

On plat No. 16, after the cowpeas planted last year were plowed under, plant holes were made and 190 coffee seedlings and 28 guaba seedlings for shade were planted in the same way as on plat No. 14. All are doing very well.

### EXPERIMENTS WITH NEW PLANTINGS.

Fourteen acres of virgin forest land have now been cleared, laid out in fields, and partly planted. The clearing consisted of—

| | Cost per acre. |
|---|---|
| Cutting away the underbrush, followed by felling the trees | $5.50 |
| First burning (which destroyed all the smaller limbs and twigs), cutting and piling remaining timber, and final burning of piles | 5.50 |
| Total cost of clearing per acre | 11.00 |

The very heavy timber, too heavy to be piled, was allowed to remain untouched. The soil thus prepared was lined and staked at distances of 7 by 7 feet, and according to these stakes a map showing the roads and different fields was made. Trails giving access to all fields have been made, and such small wooden bridges as were necessary were constructed. All plants set are doing well.

## IMPROVEMENT IN PORTO RICAN COFFEE.

Coffee and shade trees have been planted for experiments with plant distances, as follows:

| | No. of trees. |
|---|---|
| 4 by 4 feet, eastern exposure | 229 |
| 4 by 4 feet, western exposure | 406 |
| 6 by 6 feet, western exposure | 112 |
| 6 by 6 feet, eastern exposure | 148 |
| 8 by 8 feet, eastern exposure | 54 |
| 8 by 8 feet, western exposure | 120 |
| 10 by 10 feet, eastern exposure | 50 |
| 10 by 10 feet, western exposure | 80 |
| 12 by 12 feet, eastern exposure | 34 |
| 12 by 12 feet, western exposure | 98 |
| 7 by 7 feet, exposed from all sides | 334 |
| 7 by 7 feet, eastern exposure | 191 |
| Total Porto Rican coffee trees planted | 1,856 |

This close planting has been used in order to find out whether it would be profitable to harvest from double the quantity of trees while they were small and to remove one-half for transplantation to another site as soon as the trees have become so developed that their branches touch each other.

For experiments with topping, crossbreeding, etc., land is in course of preparation and will soon be planted, for which 1,155 fine seedlings are ready in the nursery beds.

## PLANTING OF FOREIGN COFFEE.

Owing to the difficulty of procuring foreign coffee and the loss of germinating power of coffee during long transportation, due in several cases to the poor preparation of the seed by shippers, it has not been possible to grow a representative collection of all coffees of different countries of the world. I regard it as of the highest importance to secure with the least possible loss of time all these different coffee varieties, so as to be able to select out of them the very best and most suitable to the American palate with which to improve our crop, either by direct planting or by crossbreeding. Thus far have been planted:

In fields:
  70 Hawaiian trees, received from W. W. Brunner.
  58 Ceylon hybrids, probably Maragogype and Ceylon seed, received from United States Department of Agriculture, Section of Seed and Plant Introduction, Washington, D. C., No. 8682.
  10 Philippine trees, received from Mr. Bliss, ex-private secretary of governor of Porto Rico.
  5 Haitian trees, received from officers of Dutch man-of-war *De Ruyter*.

In nursery beds:

4 Nuevo Café Pieraldi, received from Mr. Felipe Pieraldi, Yauco. This is probably a sport and similar to the many-seeded coffee received in 1873 by the botanical garden, Buitenzorg, Java, from Menado (Celebes).

In seed beds:

| | |
|---|---|
| 814 | Alta Verapaz, Guatemala, received from Mr. José M. Valdés. |
| 461 | Maragogype, from Guatemala. |
| 30 | Caracolilla (?), from Guatemala. |
| 30 | Maragogype, from trees grown in Porto Rico. |
| 180 | Liberian, from Trinidad. |
| 228 | Abeokuta, from St. Lucia. |
| 206 | Mauritius. |
| 221 | Preanger, from Java. |
| 192 | Menado, from Java. |
| 204 | Padang, from Java. |

Besides making experiments with coffee, which necessarily takes a long time before results are obtained, experiments with other plants have been undertaken which may give immediate results in improving the condition of the people living in the coffee regions and yield the planter profits between the coffee seasons. Also, experiments have been begun with such crops as may prove valuable additions to agriculture in the coffee regions in soils not occupied by coffee. For these objects the following have been planted: Bananas from the station at Mayaguez and other sources, 132 plants of 28 varieties; yautias, 177 plants of 12 varieties; tea, 19 plants of 3 varieties. There have also been planted besides trees suitable for shading coffee certain economic fruits, as oranges, lemons, and figs, and other trees, such as rubber, eucalyptus, etc. A number of varieties of yams and sweet potatoes are planted, and experiments are underway in cotton growing for the interior high lands of the island.

## REPORT OF J. VAN LEENHOFF, TOBACCO EXPERT.

The information embodied in the first part of the following article was gathered during a trip of two months and a half through the island of Porto Rico from planters and manufacturers in the tobacco-growing districts of Aibonito, Cayey, Cidra, Caguas, Aguas Buenas, Comerio, Arecibo, Utuado, Yauco, and Jayuga, several days being spent in each district. Not only were investigations made into the local methods of growing tobacco, but typical tobacco samples were secured from each of the above districts for further study in the laboratory. Samples of typical soils and subsoils were obtained for chemical and physical examination.

In Porto Rico the seed bed is usually made on high inclined land and sometimes on level lands called "vegas." The high lands are, however, preferred, because they are more exempt from the depredations of insects. The preparation of the bed usually consists in burning the ground and digging it up with a hoe, the time of preparation ranging from August 1 in some districts to September 1 in others. As a rule the seed bed is sown about the close of August. In order to have the plants ready for later setting out the bed is sown a second time from eight to fifteen days afterwards. In sowing, the seed is simply scattered over the bed, the quantity used being always exceedingly large in all districts. The seed is from plants of the second, or sucker, crop, and no seed selection whatever is done. In general, only a small percentage of seed reaches germination, which takes place from eight to twelve days after sowing. It requires from forty-five to sixty days for the plants to reach a size suitable for transplanting, at which time they have about eight leaves. The plants are usually left too long in the seed bed, so that they are too large for transplanting, due to the increased evaporation on the enlarged surface of the leaves.

The land is plowed in July and August and the native wooden plow is generally used, as only a very few planters have modern American steel plows. In fact, the agricultural tools and implements of all kinds are of the most primitive nature. The field is again plowed in October and gone over with a hoe, some planters using a harrow. Planting is usually begun in November. The distance between the plants in the row varies from 12 to 18 inches and the rows are from 20 to 36 inches apart. Not a single instance is known where tobacco is planted with the special object of raising wrapper or filler. The natives are very careless in getting the roots of the plants straight in the earth, and the writer has often seen seed plants set out with the tap roots doubled upon themselves. The young plants are pulled out of the seed bed by hand, often without any rootlets and frequently with the tap roots broken off. In setting out the seed plant the usual method is to take the plant in the left hand and to place it in a horizontal position in the hole prepared by one stroke of a hoe. A piece of hard earth is then pressed on the roots. The land is generally cultivated and hoed too deeply, the natives seeming not to have any fear of injuring the roots.

Topping generally takes place from forty to sixty days after transplanting, and consists in pinching off the terminal bud and leaving the required number of leaves on the stalk. Porto Rican tobacco is in most cases topped too low. The object of low and early topping is to obtain larger and heavier leaves. This practice of low topping and late harvesting is attributable to the fact that during the Spanish régime, prior to 1898, the market demanded a dark, heavy leaf, containing a large amount of nicotine. The American market, on the contrary, which now uses the greater part of the Porto Rican tobacco, calls for a light, thin, mild leaf. Accordingly the system of harvesting should be changed in order to meet the new demands. After topping, many planters weed and cultivate again.

The leaves begin to ripen from thirty to forty days after topping, which may be noticed by their turning somewhat yellow. In this condition it is cut close to the ground. The plants are usually overripe when cut. After cutting they are laid on the ground until slightly wilted before being taken to the curing shed, the usual practice being to take a bundle of five plants or more in each hand or to bind a larger number on a pole which is then carried on the shoulder. Naturally a number of plants are permanently injured by this careless manner of carrying the tobacco.

The plants are hung together the first day and then separated. Very few Porto Rican planters follow the Cuban system of harvesting, which consists in cutting the leaves from the top down in pairs and hanging them across the arm. When ten or more pairs have been hung in this manner they are slipped off on a pole of about 4 yards in length and taken to the curing shed. After the tobacco has been cut earth is thrown over the stubble, in preparation for the second crop. Sometimes this process is repeated for the third crop. Very little care is taken with the second or third crops, which are, in fact, of rather inferior quality.

No attention is paid to the question of protecting the young plants from insects and diseases peculiar to them, which are much the same as those attacking tobacco plants in the United States. To guard the young plants against the ravages of the changa or mole cricket, it is a common practice to wrap a leaf of the mamey or mango around the stem when the plant is first set in the field, allowing the upper edge of the leaf to project above the ground. The use of Paris green, Bordeaux mixture, or other poisonous remedies is unknown.

The tobacco shed is a very primitive affair in most sections, consisting of a wooden frame thatched with straw and the sides covered with the same material or palm leaf to shelter the tobacco from the elements. The shed varies in size from 36 to 120 feet in length. No attention is paid to ventilation or to the situation of the curing shed with reference to sun, wind, or rain. No openings are provided to admit moist or dry air. Tobacco is very often seen hanging in stables and rooms of houses. Sheds with sides completely open are frequently used. It is the usual custom to leave the tobacco hanging in the shed twenty-one days. The plants are then placed between green plantain leaves in piles without removing the leaves from the stalks, and they are allowed to remain from one to seven days in this position, according to the locality and circumstances, with the object of producing the first fermentation and making the tobacco moist enough to strip. After stripping or removing the leaves from the stalks they are separated into different classes called "capas," "tripas y capas," "tripas," and "boliches"—i. e., wrappers, fillers and wrappers, fillers, and bottom or sand leaves. They are then tied into bundles.

Fermenting is done in wooden boxes and occupies a period of about three months, after which a further classification is made, the leaves being then tied into hands and baled. Porto Rican tobacco is not, as a rule, sweated enough, and, as a consequence, many of the cigars made from it have a green and acrid taste. Some planters hang the tobacco plants 45 inches apart, leaving them from twenty-two to forty days. The leaves are then stripped from the stalks and sometimes separated into top, middle, and bottom leaves. Hands are made of from 80 to 100 leaves and these placed in round piles from one-half yard to 2 yards in height and 2 yards in diameter. Green plantain leaves are placed under each pile and the whole covered with them. The temperature is ascertained by merely inserting the hand into the pile, which remains in this condition from ten to twelve days, after which the tobacco is kept in wooden boxes for about fifteen days. When taken from these boxes it is classified into wrapper, filler, and wrappers and fillers. After classification it is wrapped in green plantain leaves and again placed in boxes. In from thirty to sixty days the tobacco is ready for use. Still other methods are in use, one of the most common being to make piles from 2,000 to 5,000 pounds in weight. After standing from six to eight days these piles are torn down and rebuilt. After another period of eight days they are again rebuilt in somewhat larger piles and are allowed to stand one or two months, after which they are ready for baling. Many merchants sweat them over again for about one month, after which the leaves are classified into—

Wrappers—first, second, and third sizes—light and dark.
Fillers—first, second, and third sizes—light and dark.

Some planters endeavor to secure light colors by making their fermenting piles long and very narrow, being only two hands wide, thus preventing as much as possible a rising temperature. This method retains the light colors, but results in little or no fermentation, thus rendering the tobacco unsuited for the market on account of its green and bitter taste. In this condition the tobacco can not be safely placed in the warehouse.

Porto Rican tobacco seed is always grown from the second or what is commonly called the "sucker" crop. No special care is taken with the seed-producing plants, all the plants in the field being allowed to produce seed. The seed, good and bad, after ripening, is harvested together. A large part of this seed does not germinate, and that capable of germination is in great measure from degenerated plants and produces seed plants having many undesirable qualities.

This practice explains the large amount of seed needed for a small area of seed bed. Such plants, furthermore, produce plants lacking in vigor, and this explains the fact that planters repeatedly have to reset plants in the field. As a result of this method, many tobacco fields produce a large number of leaves of all kinds, sizes, and shapes, which are wholly unfit for any practical purpose. Irrigation is extremely rare in Porto Rico, though droughts frequently occur and depreciate or destroy the tobacco crop. It is believed that where conditions are favorable money expended in irrigation would prove a profitable investment. Drainage is employed in a few localities only, the usual practice in the hilly lands being to dig ditches above the tobacco, and thus divert the water and prevent the overflow of the fields. In the level lands the drainage methods, as now practiced, could be very much improved. In many parts of the island severe losses were sustained during 1903-4 from the presence of standing water in the fields. Two seasons before the weather was quite dry, and the tobacco crop suffered from drought. This shows beyond a doubt the necessity for providing both drainage and irrigation in order to guard against unfavorable climatic conditions.

Inspection of samples of tobacco soils at the time they were taken showed that, as a rule, their texture was too heavy, as compared with similar samples of typical tobacco soils in the United States, for the production of a high-grade cigar tobacco, a fact brought out by the inspection of the following table, furnished by the Bureau of Soils of the Department of Agriculture:

*Mechanical analyses of soils and subsoils from typical tobacco fields in several of the principal tobacco-growing districts of Porto Rico.*

[Fine earth.]

| No. | Locality. | Description. | Organic matter. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 9372 | (1) 8 kilometers NW. of Aibonito. | Valley "La Plata," soil, 0-10 inches. | 5.97 | 3.24 | 6.02 | 4.20 | 12.64 | 10.04 | 31.72 | 31.98 |
| 9373 | (2) 8 kilometers NW. of Aibonito. | Valley "La Plata," soil, 0-12 inches. | 3.75 | 6.68 | 7.28 | 2.72 | 4.94 | 7.20 | 37.28 | 33.70 |
| 9374 | (3) ¼ kilometer SE. of Cayey. | Gravelly sandy loam, 0-10 inches. | 4.35 | 10.86 | 12.82 | 5.68 | 10.18 | 7.96 | 25.82 | 26.68 |
| 9375 | (4) ¼ kilometer SE. of Cayey. | Brown stony loam, 10-20 inches. | 2.37 | 6.06 | 10.24 | 4.50 | 7.80 | 9.88 | 31.84 | 29.54 |
| 9376 | (5) ¼ kilometer SE. of Cayey. | Brown sandy soil, 0-12 inches. | 1.33 | .52 | 3.16 | 3.62 | 15.14 | 18.02 | 33.36 | 26.18 |
| 9377 | (6) ¼ kilometer SE. of Cayey. | Subsoil of 9376, 12-20 inches. | .78 | .84 | 4.30 | 4.32 | 15.22 | 17.80 | 32.38 | 25.14 |
| 9378 | (7) 3 kilometers SW. of Cidra. | Dark sandy loam, 0-12 inches. | 1.85 | 1.72 | 4.70 | 3.00 | 11.18 | 8.94 | 38.50 | 31.20 |
| 9379 | (8) 3 kilometers NE. of Comerio. | .....do .............. | 2.53 | 4.98 | 9.10 | 5.20 | 11.46 | 8.36 | 32.96 | 27.66 |

*Mechanical analyses of soils and subsoils from typical tobacco fields in several of the principal tobacco-growing districts of Porto Rico*—Continued.

| No. | Locality. | Description. | Organic matter. | Gravel, 2 to 1 mm. | Coarse sand, 1 to 0.5 mm. | Medium sand, 0.5 to 0.25 mm. | Fine sand, 0.25 to 0.1 mm. | Very fine sand, 0.1 to 0.05 mm. | Silt, 0.05 to 0.005 mm. | Clay, 0.005 to 0.0001 mm. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| 9380 | (9) 4 miles SE. of Caguas. | Brown sandy loam, 0-10 inches. | 1.44 | 5.30 | 8.26 | 5.22 | 11.10 | 11.32 | 32.40 | 25.80 |
| 9381 | (10) 4 miles SE. of Caguas. | Subsoil of 9380, 10-20 inches. | 1.36 | 5.80 | 6.54 | 4.28 | 10.12 | 10.40 | 33.54 | 28.96 |
| 9382 | (11) Caguas...... | Brown sandy loam, 0-10 inches. | 1.29 | 6.22 | 14.98 | 9.50 | 21.92 | 17.50 | 15.36 | 14.34 |
| 9383 | (12) Caguas...... | Subsoil of 9383, 10-20 inches. | .82 | 2.42 | 5.96 | 3.50 | 8.02 | 10.76 | 42.04 | 26.70 |
| 9384 | (13) ½ kilometer E. of Aguas Buenas. | Dark loam, 0-10 inches. | 2.11 | 3.68 | 7.16 | 4.42 | 8.62 | 8.46 | 41.62 | 25.98 |
| 9385 | (14) ½ kilometer E. of Aguas Buenas. | Yellow loam, 10-20 inches. | 1.07 | 1.80 | 4.90 | 4.24 | 10.28 | 9.80 | 43.24 | 25.74 |
| 9386 | (15) ½ kilometer E. of Aguas Buenas. | .....do ............... | 1.25 | 3.20 | 6.36 | 4.06 | 7.76 | 8.96 | 44.90 | 24.68 |
| 9387 | (16) ½ kilometer E. of Arecibo. | Fine sand, 0-12 inches. | .59 | .04 | .50 | 4.32 | 53.32 | 22.94 | 11.72 | 6.98 |
| 9388 | (17) Jayuya ..... | Sandy loam, 0-10 inches. | 3.19 | 3.16 | 5.30 | 3.04 | 7.46 | 9.52 | 45.82 | 25.56 |
| 9389 | (18) 1 kilometer from Jayuya. | .....do ............... | 2.08 | 7.22 | 16.60 | 8.48 | 17.60 | 11.14 | 15.10 | 23.58 |

It will be seen that with but two exceptions the percentages of clay and silt are too high. Under the old régime of tobacco production in Porto Rico the fact that the tobaccos produced have, as a rule, been rather coarse, dark in color, and too heavy to meet the demands of the United States markets is attributable to the heavy texture of the soil. By improved methods of topping, harvesting, curing, and fermenting it has been observed that in this tropical climate a higher grade of cigar tobacco is produced. Experiments by the American Tobacco Company at Aibonito with soils that contained 31.98 per cent and 33.70 per cent of clay have shown that it is possible, through the shading of the tobacco with cloth, the application of fertilizers, and the use of improved methods of harvesting, curing, and fermenting, to produce tobacco yielding a high percentage of excellent wrapper leaves possessing good qualities as to elasticity, lighter colors, fine texture, and fair combustibility. In general, the Porto Rico tobacco leaves have too heavy veins and too thin body when grown under shade, and experiments in breeding and selection are greatly needed to secure a type of tobacco better adapted to use as wrappers. In this connection it may be said that the climatic conditions in the Tropics seem to be more favorable to the production of high-grade tobacco than in any of the more northern latitudes.

As a result of the above preliminary investigation is was concluded that Porto Rico presents very favorable conditions for the production of high-grade tobacco if localities are chosen with suitable soil areas and favorable climatic environments. Investigation also shows that for the most part the methods employed by the planters are primitive and that there is great need of their adopting more up-to-date methods. It was decided, therefore, to undertake experiments in growing, curing, and fermenting tobacco, but owing to the limited funds available for the work it was necessary to arrange for cooperation with an interested tobacco grower. Such an arrangement was made with a planter near Aguas Buenas, under which he furnished the land, labor, buildings, and material, in so far as this did not interfere with his regular business. The facilities offered, however, by the equipment of the ordinary planters are at the best unsatisfactory in many ways for experimental purposes, and because the funds available would not permit the necessary modifications of these conditions some of the experiments undertaken failed.

## RESULTS OF EXPERIMENTS.

### EFFECT OF SHADE IN THE SEED BED.

Several seed beds were constructed for experimental purposes, the sides being supported by old boards or poles. (Pl. XX.) Half of each shed was shaded by a movable straw shade, the other half remaining without shade. The shade was supported in an inclined position about 4 feet above the beds. The advantage of the shade lies in reducing the evaporation, and thus enabling the seed to germinate quicker and more perfectly; it furthermore protects the beds from washing by heavy rains. It often happens, as it did in 1903, that many seed beds are destroyed by heavy rains either by carrying away the seeds before they germinate or by washing out the plants when quite small. Records showed that the seed in the shaded portion of the beds came up several days earlier than in the unshaded portion. After the plants were all well grown the straw shade was removed for a short time each day early in the morning and late in the afternoon. The time of exposure was gradually increased. and eventually the plants were shaded only from 10 a. m. to 3 p. m. A few days before transplanting in the fields the shade was removed and the plants exposed throughout the day. One portion of the shade was allowed to remain, and it was observed that while the plants in the shaded portion of the beds came up earlier and looked healthier during the first weeks, after that time those without shade appeared better, grew faster, and were finer, more vigorous, and larger. The plants under permanent shade did not thrive so well, owing to the lack

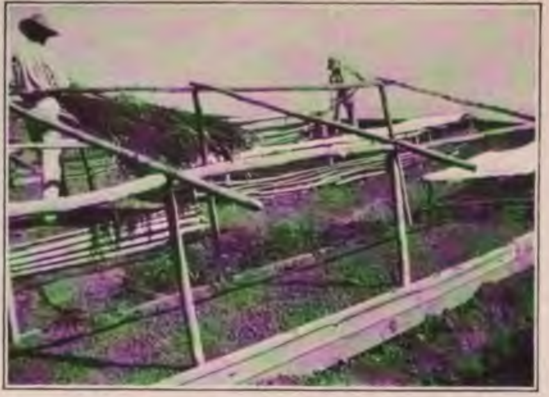

FIG. 1.—CONSTRUCTING STRAW SHADE FOR SEED BEDS, PORTO RICO.

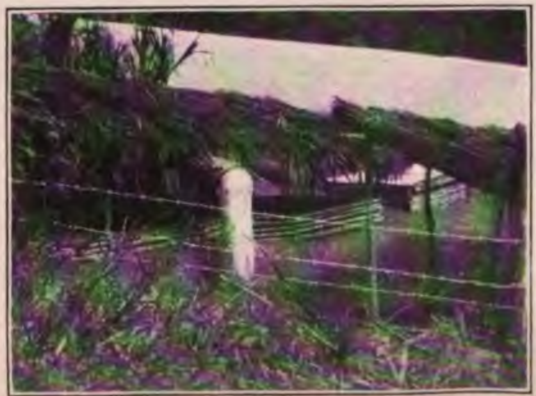

FIG. 2.—TOBACCO-SEED BEDS PROTECTED BY STRAW SHADE, PORTO RICO.

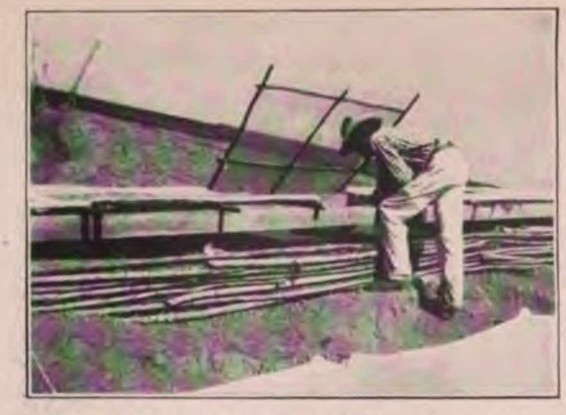

FIG. 3.—TOBACCO-SEED BEDS PROTECTED BY CLOTH COVERING, PORTO RICO.

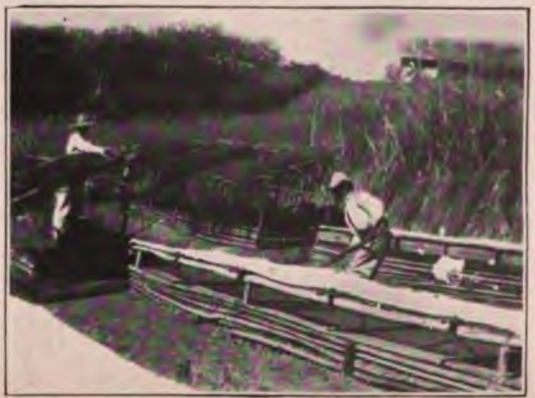

FIG. 4.—CLOTH AND STRAW AS COVERING FOR SEED BEDS, PORTO RICO.

of sunlight. The conclusion drawn from the above experiments is that shade in the first stages of growth is beneficial, but that day by day, as the plants grow, the time of exposure to the sun should be longer, until when they have reached the size for setting out the shade shall have been entirely removed. This process toughens the plants and enables them to stand the sun better when they are finally transplanted.

Cloth shade was also tried, and seemed to serve equally as well as the straw, the first being less dense than the latter. While it allowed most of the rain to pass through, it served as a regulator by breaking the fall of the rain, thus preventing washing away. It is believed that straw shade offers sufficient protection against the washing of the seed beds to alone justify its adoption, and that in practice it would be well to dispense with it as soon as the plants are well established and all danger from washing away is passed. Another seed bed was divided into five plats, each covered with a different colored cloth, the colors being white, blue, green, yellow, and red. This was to test the effect of the color of shade on the tobacco plant. These experiments might have given some data of value in the growing of tobacco seed under cloth, but, unfortunately, the seed used on these plats was imported Habana, and only a few plants were secured.

It is deemed very advisable to place the seed bed in Porto Rico, as is done in other countries, on low lands in preference to high, inclined lands, and in such proximity to the house of the planter as to make it convenient for him to give it all the attention possible, as, for example, to see that the seed bed is always kept moist.

### EFFECT OF SHADE IN TRANSPLANTING.

Leaves of mamey and mango, common in Porto Rico, were used as a shade for the young transplanted plants by inserting the petiole in the ground and inclining the top of the leaf toward the plant. This shielded it from the direct rays of the sun during the hottest part of the day and has proved in general very satisfactory. The same method is followed in Sumatra—small, thin, petal-shaped boards being used instead of leaves. A trial was also made to ascertain the effect of mamey leaves as a protection against cutworms and mole crickets. The leaves were fashioned into cylinders, with the edges slightly overlapping, and placed in the ground with the roots and stems of the plants inside. Care should be taken to place the leaf no deeper in the soil than is necessary to prevent the crickets from boring beneath. While the mamey leaves make adequate barriers against the crickets, they are probably somewhat detrimental to the early growth of the plants, because they confine the upper roots, and also because water from rain collected within the leaves escapes very slowly, sometimes injuring the plants. Experience has shown, however, that wrapping with this leaf is advisable. It has been found that by carefully placing the roots in the soil and watering when dry it is possible to improve very much upon the native methods of planting tobacco.

### EXPERIMENTS WITH HALF AN ACRE OF TOBACCO GROWN UNDER SHADE.

It was planned to make a careful comparison of the cost of production of shade tobacco with that grown outside under otherwise the same conditions. Four-elevenths of an acre were planted under shade, and about the same date 2 acres outside. Very heavy rains occurred just after planting the outside tobacco, and a large part of the first planting was washed out. The delay in replanting and other uncontrollable factors interfered to such an extent with the outside crop that it was not worth while to carry out the comparison. The shade-grown tobacco was carefully cultivated, however, and an accurate record kept of it. Owing to the delay in getting the curing shed ready for this tobacco it was harvested in an overripe condition, and for this reason many of the bottom leaves were lost. A short time before the leaves began to ripen a disease appeared which gave rise to numerous whitish and brown spots. It spread very rapidly, and at the time of harvesting nearly all the leaves were affected, and many of them were so badly damaged as to make them useless for wrapper purposes. Some of the diseased leaves were sent to the U. S. Department of Agriculture for examination, and the Pathologist reported as follows:

> The leaves appear badly affected with the fungus *Ascochyta nicotianæ*. To the best of my opinion this fungus has not as yet been found within the limits of the United States proper, and we never heard of its previous occurrence in Porto Rico. In past years several reports of its occurrence have been made from various points in Italy. These reports, however, have been very meager, and we know very little concerning its destructive nature and practically nothing concerning methods of control. Judging from the specimens of leaves submitted it would appear to be a rather serious disease, and great care should be taken to prevent its spreading into other places.

It is quite possible that judicious fertilizing would increase the vigor of the plants and render them less susceptible to the disease. The use of a fertilizer containing a rather large percentage of potash is strongly recommended. If the soil be soggy, careful attention should be given to drainage. Diseased leaves and all leaves from a diseased crop should be burned. The approximate cost of the production of four-elevenths of an acre of shade tobacco was $250. In spite of the unfavorable conditions there were 182 pounds of wrapper and 105 pounds of filler and binder raised—287 pounds, which makes 789 pounds to the acre. The value was $296, which gives a profit of $46 for four-elevenths of an acre, or $126.50 per acre, notwithstanding the unfavorable conditions. In the previous season almost the same kind of an experiment was made by the writer in the vicinity of Jayuya on two-thirteenths of an acre. There were 171 pounds of wrappers, 36 pounds of binders, and 21 pounds of filler raised, making 228 pounds in all. This gives a yield per acre of 1,482 pounds. Samples of the light and medium wrappers were valued by the cigar factories at San Juan at $2.50 and $2, respectively, and one large factory offered $1.50 per pound on the average.

As a result of these experiments and observations in regard to larger areas that have been grown under shade in Porto Rico it may be safely said that shading increases the yield, quality, and percentage of wrappers sufficiently to make it profitable, provided it is practiced only on soils suitable for growing wrappers and the crop is given the best of care throughout the growth and the same good treatment in the curing shed.

### EXPERIMENTS WITH FERTILIZERS.

An experiment in fertilizing was carried on as an example of what any planter may easily try for himself. Sulphate of potash, acid phosphate, nitrate of soda, and lime were used for this purpose on a farm between Aibonito and Cayey. So far as the experiment was carried it indicates that the proper fertilizer for tobacco on this field is one containing a large amount of acid phosphate and a small amount of nitrogen and potash.

According to analyses reported by R. J. Davidson, of the Virginia Agricultural Experiment Station, the entire plants of a tobacco crop yielding 1,000 pounds of leaves per acre contain 66.85 pounds of nitrogen, 8.68 pounds of phosphoric acid, and 85.41 pounds of potash. The leaves of such a crop contain 44 pounds of nitrogen, 5.89 pounds of phosphoric acid, and 58.19 pounds of potash. The parts usually removed from the soil—the leaves and stalks—contain 58.9 pounds of nitrogen, 7.72 pounds of phosphoric acid, and 77.86 pounds of potash.[a]

This shows that the larger part of the fertilizing constituents is found in the leaves and stalks, and emphasizes the exacting character of the demands of the tobacco plant on the soil and the importance of returning to the soil all of the stalks and roots. This is a very important point for the Porto Rican planter, as in several places it was noticed that planters in preparing ground for future crops had thrown out of the field all the roots and stalks of the tobacco, a practice that would not have been permitted had they appreciated their value. It was also noticed that beans were harvested by cutting and removing the whole plant from the field. As this crop belongs to the leguminous family and through the agency of the tubercles on its roots has the power of taking free nitrogen from the air, becoming itself richer in this element, the vines and all unused parts of the plant should be returned to the soil. This will also increase the thinness and elasticity of the tobacco leaf as well as improve the combustibility.

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[a] Virginia Sta. Buls. 14 and 50.

### CURING EXPERIMENT.

A curing experiment carried on on a small scale seemed to indicate that a slightly lower temperature and higher relative humidity would give the best results. It was found that tobacco cured with an average temperature of 77.67° F. and with a relative humidity of 73.57 per cent was more desirable than that cured with an average temperature of 80.21° and a relative humidity of 68.30 per cent. These experiments showed the impossibility of fermenting large quantities of tobacco properly without a fermenting house so constructed that it could be hermetically closed in case of necessity, and in which the temperature and air moisture can be regulated.

### SEED-SELECTION EXPERIMENT.

An examination of the tobacco fields of Porto Rico shows that there are practically no two plants alike, so that there can not be any distinctive Porto Rican type. This, it is believed, is the result of the ignorance of the value of seed selection. In the course of these experiments cooperation was entered into with the Plant Breeding Laboratory, U. S. Department of Agriculture, and eighteen selections and crosses were secured for planting in 1903 and 1904. One set was planted at Aguas Buenas and the other at Aibonito, but the last named was destroyed by the leaf miner or splitworm. At Aguas Buenas the selections throve very well, and from them the best and most uniform plants were selected, only thirty or forty capsules being left on the main flower stalks. These were covered with manila-paper bags to prevent cross fertilization. Seeds of the selections have been saved for further work along this line. This will undoubtedly be the beginning of a great improvement in the uniformity of Porto Rican tobacco planting, and it is believed that by this process strains can be bred for special qualities—as, for example, increased yield, more desirable shape, finer texture, etc.

The texture and structure of the soil, as has already been pointed out, have a great influence on the character of the tobacco produced. Soils light in texture—that is, having a relatively large amount of sand and a small amount of clay—are best suited to the production of wrapper tobacco, and give leaves of medium size, fine texture, and good color. Filler crops may be grown to better advantage on a heavier soil. The character of subsoils is also important. A sandy soil and a low rainfall without irrigation should be underlaid at a depth of 1½ to 2 feet by a somewhat stiff subsoil, otherwise the plants will suffer from rot. On the contrary, if the rainfall be abundant a very porous subsoil will give the best results, because of the drainage which it affords.

### TIME OF TRANSPLANTING FOR WRAPPER AND FILLER.

In Porto Rico the best season for planting tobacco seems to be in the winter, which is also true of Cuba. The rainfall at that season is less and the temperature several degrees cooler than in summer. Under the influence of the greater warmth and moisture of the summer the plants grow more rapidly, but the leaves do not acquire the desirable aroma they have when grown during the period in which less humidity and plenty of sunshine prevail. When grown in the summer, there is also danger from loss by standing water in the fields. Diseases are more prevalent at that time and leaves contain more nicotine. It is very important to gauge the time of planting so as to avoid excessive rainfall and extreme drought during the growing season, and also to have the harvesting and curing period occur in comparatively dry weather. Generally the best time for transplanting the wrapper tobacco seems to be about the end of October or the beginning of November. This brings harvest time about February 1, and gives that month and March, which are on the average the driest of the year, for curing. This also avoids serious damage by the flea-beetle, which is most prevalent during the dry season. Study of the Weather Bureau tables for Porto Rico shows that on the average November is a month of high rainfall, but that during the months of December, January, and February it rapidly decreases. If, therefore, a level, poorly drained land is to be used for the wrapper crop there is danger of its being damaged and sometimes destroyed by wet weather. In such cases it is advisable to defer planting until December.

For the filler crop it is advisable to plant about the middle or close of December, so that the principal growth will be made during the drier weather of February and March and the resulting slower growth develop a finer aroma. Care and thorough cultivation should be given the tobacco fields during the early growth of the plants. During dry weather the surface of the soil should be frequently stirred in order to destroy capillarity, thereby reducing evaporation directly from the soil and conserving the soil moisture for the use of the plants. Any dry blanket that can be placed between the atmosphere and the damp soil will check this evaporation. The most practical protection is a covering of finely pulverized dry soil 2 or 3 inches deep. Surface cultivation not only reduces the loss of water from the soil, but also prevents the accumulation of the soluble plant food immediately at the surface, where it is out of reach of the plant roots. Cultivation should not be too deep, especially near the plants, as it destroys many of the small roots, thus lessening the feeding power of the plants. It also facilitates the formation of nitrates. Cultivation should not be undertaken when the soil is too wet. Stirring the soil in such a condition gives it a bad physical condition. If bad weather be continuous, all weeds should be removed with as little cultivation as possible. During the process of cultivation the soil should gradually be worked toward the plants, thus hilling them up and preventing them being blown down by wind.

For wrapper purposes topping should be done as high as possible when abundant sunshine and favorable conditions prevail during the growing season. When the weather is cloudy and rainy, topping should be done somewhat lower and a smaller number of leaves left on the plant. This is especially true of shade-grown tobacco, as the shade has a tendency to still further increase the humidity to which the fields are subjected. Experience has shown that instead of breaking off the suckers in the axil it is better to leave a small part of the stem of the sucker about 1 inch in length. In this way fewer suckers will appear. The removal of the suckers throws the strength of the plant into the leaves, but if there is a tendency, through having topped the plants too low or through changed weather conditions, for the leaves of the plant to become too thick this may be counteracted by leaving one or two suckers on the plant. In harvesting it should be noticed that overripe leaves become less combustible, are less elastic, have darker colors, and contain more nicotine, all of which is undesirable. In unripe leaves the colors are difficult to change in the curing process, and often turn from green to black in the fermenting pile. After priming the leaves should be transported to the curing shed, provided with burlap for covering the top and sides, so as to protect the leaves from dust and the direct rays of the sun.

With the cut system of harvesting it is advisable to cut the plants when the middle leaves show maturity; for wrapper purposes early in this stage, for filler a little later.

### CURING SHED.

There are five things to be considered in connection with the construction of the best sort of curing shed: Direction, situation, dimension, construction, and ventilation. The direction of the shed should be NNE. by SW., because in Porto Rico the prevailing wind is from the east. Where the direction of the prevailing wind is different the direction of the shed should conform to it. The shed should be so built that when the ventilators are open the wind will not blow directly in at the openings. When the wind blows directly in at the ventilators the tobacco near by dries too rapidly and the leaves remain green instead of changing to desirable colors. The situation of the curing shed depends upon the requirements of the farm, but, other things being equal, it should be convenient to the tobacco field, and should be as much as possible sheltered by other buildings or trees on the side from which the wind comes. Close proximity to marshes, streams, or wet land should be avoided because the dampness from such sources is conducive to molds and pole sweat. The dimensions of the curing shed will depend upon the size of the crop, but the width should never be too great for good ventilation in all parts of the interior when it is filled with tobacco. The width should not exceed 30 feet and the height should be nearly equal to the width; no definite measurement can be given for the length.

The construction of the curing shed will depend to a certain extent upon the available and most economical material for the structure. In Porto Rico, as a rule, the framework may be of poles cut from native trees. Inch boards of either native or imported lumber will probably be most desirable and cheaper for the sides, while for the roofs either palm leaves or grass is suitable. Thatched roofs favor a more equable temperature than boards. The metals, being good conductors of heat, should not be used for roofing purposes. It is most important that the shed be so constructed that the temperature and humidity can be controlled. In order to accomplish this it should be sufficiently tight to prevent air currents when closed. The ventilators should be at frequent intervals and sufficiently large to secure any desired amount of ventilation. They should be so constructed that they open against the wind and can be readily adjusted to any sized opening quickly or can be tightly closed.

During the early period curing should be effected by slow and continuous ventilation. After the colors are obtained ventilation may become rapid and periodic. The first is had by opening the small ventilators at the bottom and top or side walls or by opening the large ventilators only slightly. The rapid ventilation is effected by opening the large ventilators as wide as possible, always guarding against the direct entrance of wind or sunshine.

The nature of the process which takes place in the curing of tobacco has not yet been thoroughly worked out, but there is a loss of water equal to about 80 per cent of the green weight of the leaves, and a modification of the chlorophyl and other contents of the leaf and the resulting change in color from green to yellow, red to brown. If the leaf cure in a current of hot air, the water is quickly lost and the color remains green, because sufficient time has not been allowed for the biological process which causes the color changes to take place. If the leaves remain longer in the hot air current, they may also lose their fermenting power. In order to facilitate the transformation of the matter of the leaves a slow curing is necessary. If, however, the circulation of air is too limited, reduction takes place and the leaves turn black, losing their resistance and elasticity. In a general way ventilation should be slow, with a constant circulation of air around all of the leaves, until the parenchyma changes color. Rapid ventilation should be avoided during the early stages of curing, except for short periods after very damp spells, when it may be resorted to in order to drive out the excess of moisture. High temperature and excessive humidity must be avoided.

# REPORT OF IRRIGATION AND DRAINAGE INVESTIGATIONS, 1904.

By Elwood Mead, *Chief of Irrigation and Drainage Investigations.*

## IRRIGATION.

### IMPROVEMENTS IN METHODS OF IRRIGATION.

Measurements of the water used in irrigation have now been carried on for seven years. They show the great difference which exists between good and bad practice, and the benefits which improved methods of applying water will bring. Enormous quantities of water are used under some canals, while equally good results under others having the same conditions are secured with very much less water. The canal of the Turlock irrigation district of California diverted enough water in 1904 to cover the 19,000 acres irrigated to a depth of 8.34 feet, and enough of this water was actually delivered to the land to cover it to a depth of 6.84 feet. The Modesto Canal diverted water enough to cover the land irrigated to a depth of 13.18 feet, and of this enough reached the land to cover it to a depth of 11.13 feet. In the same State and in a section having a longer season and greater evaporation, the water diverted by the Gage Canal for a number of years would cover the land irrigated each year to a depth of 2 feet, or less than one-third the water used under the Turlock Canal and less than one-fifth that used under the Modesto Canal.

Measurements of the water used in irrigation along the Raft River in southern Idaho show that enough was used in 1904 to cover the land to a depth of 6 feet. There is great room here for extension of the area by economical use.

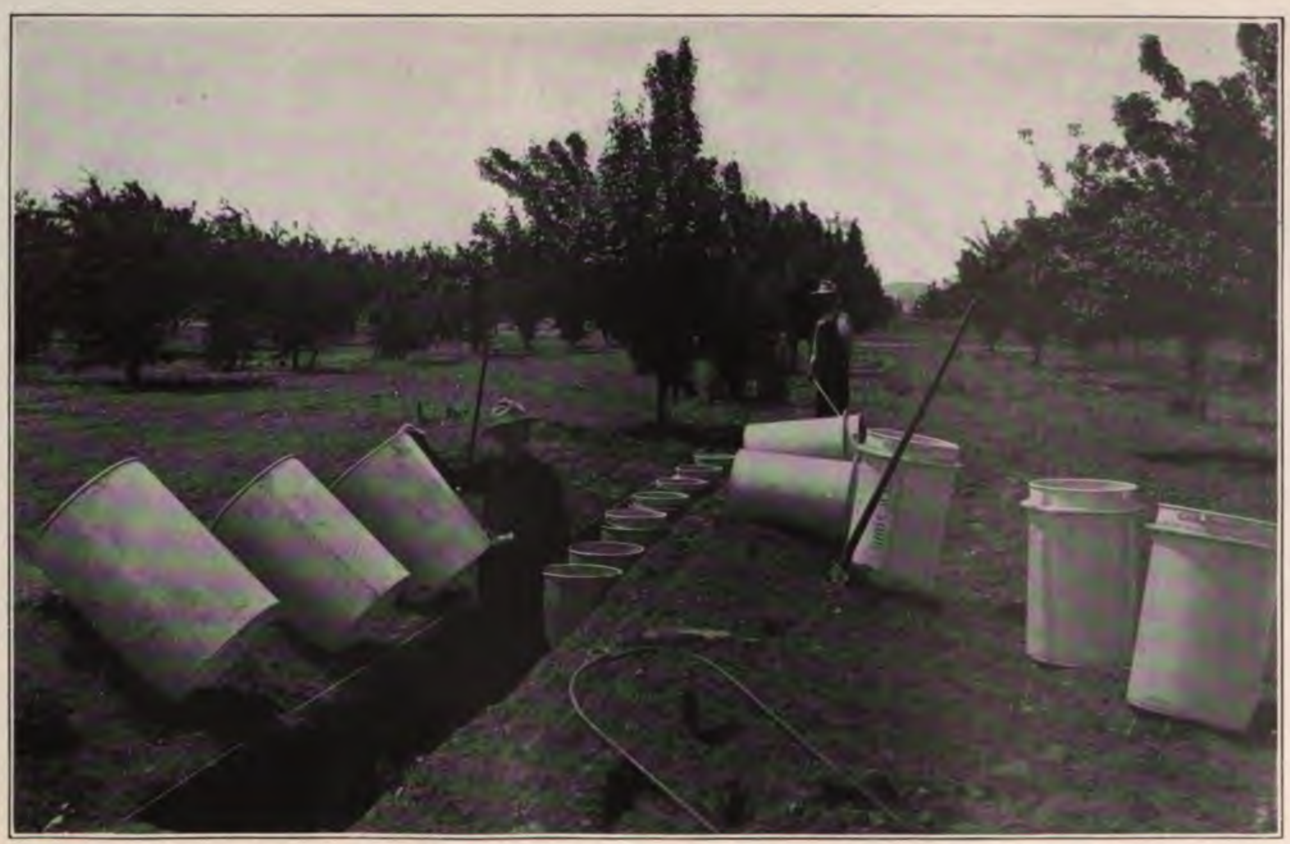
Measurements of the quantity of water used under the Sunnyside Canal in Yakima Valley, Washington, carried on for several years, show that the land under that canal received water to an average depth of more than 10 feet. Improvements in practice, suggested by reports from this Office and put into effect by the management of the canal, reduced the amount used in 1904 to a depth of 6 feet, a saving of about 44 per cent in the consumption of water, making possible a like increase in the acreage irrigated. That there is room for further improvement in this section is shown by the fact that there are everywhere evidences of overirrigation, in many places the lands being already swamped and in need of drainage.

The measurement of water used in 1901 in the Pecos Valley, New Mexico, under the canals of the Pecos Irrigation and Improvement Company, showed that the quantity used by the individual irrigator varied from enough water to cover the land irrigated to a depth of 1.18 feet to enough to cover it to a depth of 14.43 feet, with an average for the system of 3.33 feet. During 1904 the average depth of water used by irrigators in this valley under the Hagerman Canal, as reported by J. J. Hagerman, did not exceed a depth of 2 feet over the land irrigated.

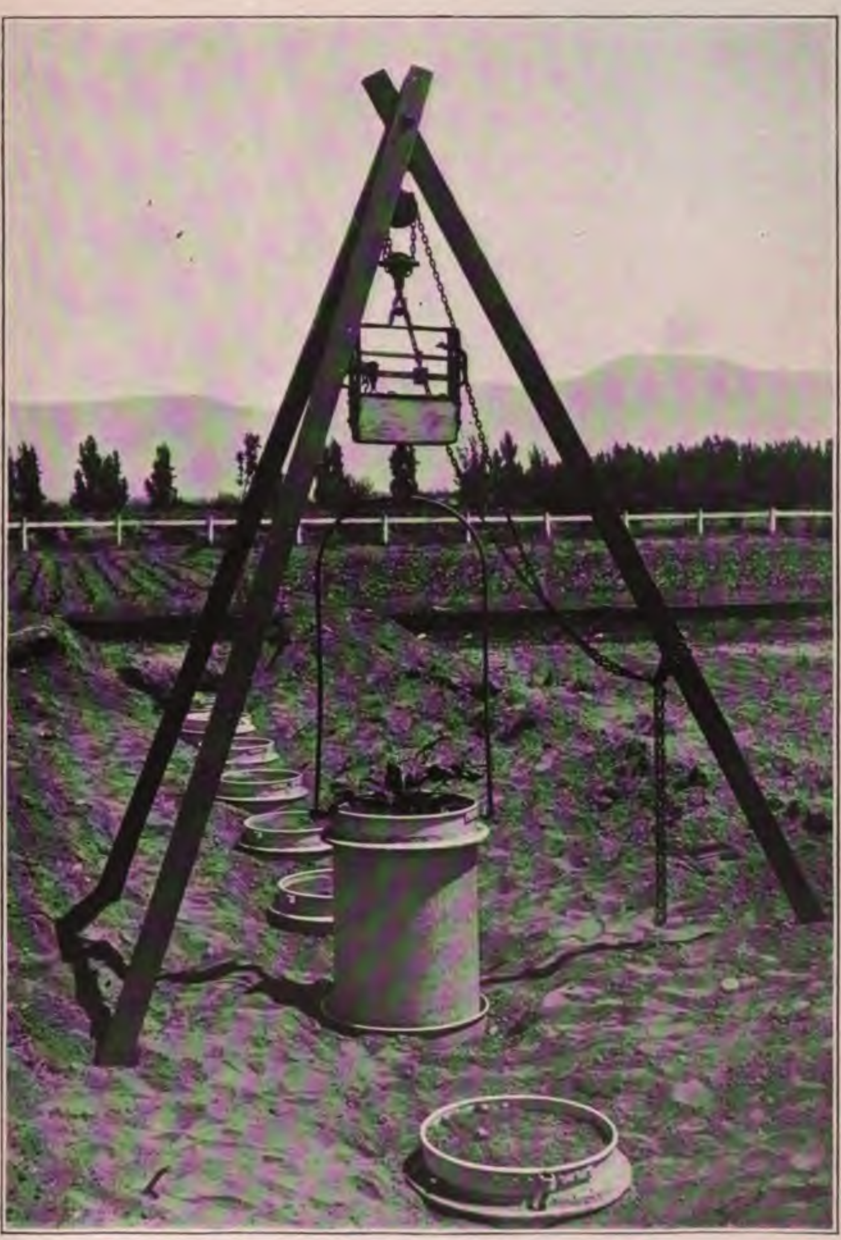
In the beginning the studies of the duty of water were directed to determining the amount used in ordinary practice, and instructions were given to irrigators whose water was being measured to use it exactly as though such measurements were not being made. In 1904 these measurements were supplemented by experiments to determine the exact needs of crops. These experiments included the application of different quantities of water to crops to determine the amount which gave the best results, the distribution of water over fields by different methods to determine how losses by seepage and evaporation could be lessened, and variations in both the amount and time of irrigation to determine its influence on the yield and quality of grain, fruits, and vegetables. Through these experiments, it is believed that improvements in methods of application will be made which will result both in a marked increase in the acreage irrigated with a given volume of water and also in increased yields. In many places increase in acreage irrigated must come from more economical use of water. A higher duty of water will make possible the extension of many canals and the irrigation of unused areas under others.

The chief losses of water by evaporation come in spreading water over fields. During 1904 experiments were made in California to determine how best to check this great loss. Plates XXI and XXII show methods of placing and weighing tanks used in measuring evaporation losses from the soil. In these experiments water was applied to similar plats by three methods—flooding the surface, in furrows 3 inches in depth, and in furrows 12 inches in depth. Taking the quantity of water evaporated under surface flooding as a basis, applying water in shallow furrows made a saving of 13 per cent, while applying it in deep furrows brought about a saving of 25 per cent.

Our experiments, while they show excessive use in many places, show that there is a point beyond which economy in water can not be pushed with profit, because of the reduction in yields which follows. Experiments to determine this were made in several parts of the arid region. The complete tabulation of the results of these measurements has not been made at the time of preparing this report.



INSTALLING WATER-JACKET SOIL TANKS FOR IRRIGATION INVESTIGATIONS AT POMONA SUBSTATION, CALIFORNIA.



APPARATUS FOR LIFTING AND WEIGHING TANKS.

to bake. It requires considerable disturbance of the soil in forming the basins and is likely to keep the roots near the surface, since the water is applied there.

### METHODS OF PREPARING LAND FOR IRRIGATION.

During the past year a bulletin (No. 145) has been published describing methods of preparing land for irrigation. The demand for this bulletin shows the need for information of this practical character. In sections of the arid region where sagebrush grows its removal is the first step in reclamation. The cost of this, as determined by a large number of irrigators, has varied in different parts of the country from $1.50 to $5 per acre. The different methods of removing brush are described in this bulletin, as are the different tools and methods employed in leveling and grading the land. The cost of leveling land, after brush has been removed, varies, of course, with the original roughness of the surface and with the plan of applying water adopted, the reports from various sections giving it as from $1 to $15 per acre. The cost of laterals and division boxes also varies with the contour of the country and with the method of applying water. The total for the three items—removing brush, grading, construction of lateral ditches or checks—varied in the cases examined from $3.50 to $35 an acre. Add to this the price of a water right, from $10 to $20 an acre, and it is easily seen that the farmer under irrigation must have considerable capital to establish himself. It is also manifest that with an outlay so large the farmer can not afford to make many mistakes, either as to the tools or methods adopted, and no work that this Office has undertaken has proven more useful than the collection of information which will enable new settlers to do this work cheaply and well.

### PUMPING WATER FOR IRRIGATION.

During the last two or three years the limits of settlement in the semiarid region have pushed farther and farther westward, so that in Texas, Kansas, Nebraska, and the Dakotas there are now great stretches of what was formerly grazing land dotted over with homes. Important towns are springing up, and a comprehensive test of the possibilities of agriculture in this region is being made. The permanency of this settlement is not yet assured. It will be a failure if farmers attempt to grow the same crops in the same way as is done in regions of ample rainfall. It is believed that farming can be made a success by conserving moisture by special methods of tillage, growing crops suited to limited rainfall, and combining with this wherever possible the irrigation of small areas from wells or reservoirs. In its best form the farm of the semiarid region will combine a comparatively large area of land, varying from a quarter section to a section, which will be grazed or cultivated by rainfall, with 5 to 20 acres of irrigated land.

Hundreds of the farmers who are settling in the semiarid region wish to practice this special kind of agriculture, but they know nothing about irrigation methods. They do not know how to build reservoirs, and they are totally at sea regarding methods of putting down wells and installing pumps. In order to aid these farmers, we have combined the collection of information regarding conditions for the purpose of publishing bulletins of direction for this work, with the giving of personal advice to the people on the ground. The manner in which this is being done can be illustrated by our work in Texas in 1904. The State was divided into three districts and an irrigation engineer placed in each. One of these had for several years acted as an instructor for beginners in irrigation, and all were familiar with the operation of pumping plants for irrigation. Their duties were twofold—first to give personal advice to beginners as to how to irrigate crops and how to operate pumping machinery; next, to determine the possibilities, ascertain the cost of irrigation from the wells already in use, and the value of the crops produced. In the study of the resources of the country was included the possibility of constructing small individual reservoirs for storing storm water. In some instances the giving of personal advice to beginners in irrigation was systematized by the calling of meetings in towns where the farmers gathered together and were shown by means of illustrations, diagrams, and models how to prepare their land, how to install pumps, and some of the things to be looked after in their care. We have had numerous letters from these farmers telling of the benefit of this service and stating that it had saved them large sums of money by correcting mistakes in their original plans.

The managers of the railways traversing this territory have also shown an appreciation of the practical value of this sort of instruction and of the necessity of demonstrating how the resources of this region can be best utilized. They know that the prosperity of the farmers along their roads means the prosperity of their properties, while the failure of these farmers is certain to reflect on receipts. As a means of extending this work in 1905, the Union Pacific, Burlington, Colorado Southern, and Northern Pacific railways have each volunteered to aid in testing what can be done with irrigation from wells and small reservoirs when combined with dry farming by meeting a part of the expenses of the farmers with whom this Office will cooperate.

The possibilities of this kind of irrigation ought to be determined and the facts given wide publicity at the earliest possible moment, because the working out of successful methods of irrigation and tillage along these lines may be the salvation of many individual homes and affect the agricultural development of large areas of country for many years.

The usual estimate places the land of the arid region which can be reclaimed by irrigation from the water supplied by streams at not to exceed 10 per cent of the total area. The profitable use of the remaining 90 per cent depends very largely upon obtaining a water supply for at least a part of it from some other source. The two principal sources of added supply are underground waters and storm waters.

During 1904 investigations have been conducted to determine the best methods of utilizing water supplies from these two sources. The collection of storm waters requires the construction of reservoirs, while the securing of underground supplies requires pumping. It is believed that by the use of these two methods it will be possible for the owners of the homes on the plains to raise sufficient fruits, vegetables, and forage to provide themselves and their work animals with a food supply which will carry them over years of drought, and thus enable them to maintain their families during those years, where heretofore they have been compelled to abandon the land to avoid starvation. It will also add greatly to the comfort and pleasure of ranch life by providing a good supply of fresh vegetables and fruits for household use, and render possible the raising of fruit and shade trees, which will make ranches attractive.

The constancy of the winds on the great plains suggests the windmill as a promising source of power for pumping water, and windmill irrigation has had a successful development in the vicinity of Garden City, Kans. Facts as to the cost of mills and pumps, and the areas of land irrigated from them, were collected in this vicinity. One hundred and seven mills, varying in diameter from 6 to 12 feet, were visited. The average discharges of the pumps operated by these mills are shown in the following table. The second column gives the average amount pumped in a day with a good wind. In the third column are given the average discharges during twenty weeks, which takes into account times when there was too little wind to operate the pumps.

*Average discharge of pumps operated by windmills at Garden City, Kans.*

| Size of mill. | Acre-feet per day. | |
|---|---|---|
| | In good wind. | Average for 20 weeks. |
| *Feet.* | | |
| 6 | 0.034 | 0.010 |
| 8 | .080 | .024 |
| 10 | .170 | .050 |
| 12 | .270 | .084 |
| 25 | 1.200 | .386 |

The average area served by these mills is shown in the following table:

*Areas served by windmills of different sizes.*

| Size of mill. | Maximum. | Minimum. | Average. |
|---|---|---|---|
| *Feet.* | *Acres.* | *Acres.* | *Acres.* |
| 6 | 2.50 | 0.50 | 1.15 |
| 8 | 3.50 | .25 | 1.23 |
| 10 | 6.00 | 1.00 | 3.08 |
| 12 | 12.00 | 1.00 | 5.07 |
| 25 | ---------- | ---------- | 8.00 |

The approximate cost of mills of various sizes, the areas served by these mills, and the acre cost of providing a water supply are given in the following table:

*Cost of windmills.*

| Size of mill. | Cost. | Area served. | Cost per acre. |
|---|---|---|---|
| *Feet.* | | *Acres.* | |
| 8 | $90 | 1.23 | $73.17 |
| 10 | 120 | 3.08 | 38.96 |
| 12 | 150 | 5.07 | 29.59 |

This table shows the great reduction in cost per acre served by using large mills, but it also shows that with any mill the original outlay is quite large when compared with the cost of ditches for supplying water where water can be conveniently secured from streams.

The average annual cost of maintenance, including repairs, oil, etc., for 43 mills in the vicinity of Garden City, Kans., is given as $2.35 per acre irrigated by the mills.

A windmill does not furnish a large enough stream of water for economical use in irrigation. It is, therefore, necessary to provide reservoirs for storing the water until enough is accumulated to furnish a stream large enough for economical use. Forty-nine reservoirs storing water pumped by mills at Garden City were measured to determine the capacity ordinarily used with the mills. The following table gives the approximate average capacities of the reservoirs used with the mills of different sizes:

*Capacities of reservoirs used with windmills.*

| Size of mill. | Capacity of reservoir. |
|---|---|
| *Feet.* | *Cub. feet.* |
| 6 | 3,400 |
| 8 | 3,400 |
| 10 | 4,000 |
| 12 | 11,000 |

The period during which these reservoirs will hold the discharge of the pumps during good winds is shown in the following table:

*Length of period reservoirs will hold discharge of pumps.*

| Size of mill. | Number of days. |
|---|---|
| *Feet.* | |
| 6 | 2.3 |
| 8 | 1.0 |
| 10 | .6 |
| 12 | 1.0 |

It is probable that better results might be secured if larger reservoirs were built, so that larger streams might be used in applying water to land. There is always waste in using a small stream, as a large part of the water is absorbed by the soil or evaporated while it is being spread over the land. The average cost of these reservoirs is given as $60. This, of course, is only a rough approximation.

Taking the 12-foot mill as a basis, we have the following statement of the cost of raising water with a windmill, not taking into account the cost of the well and pump:

*Cost of windmill irrigation.*

| | |
|---|---|
| Cost of mill | $150.00 |
| Cost of reservoir | 60.00 |
| Total cost | 210.00 |
| Area irrigated ..... acres | 5 |
| Cost per acre | $42.00 |
| ANNUAL COST. | |
| Interest on investment, at 7 per cent | $2.94 |
| Depreciation, 10 per cent | 4.20 |
| Maintenance | 2.35 |
| Annual cost per acre | 9.49 |

The average lift of water in the vicinity of Garden City is but 10 feet. Where lifts are greater the quantity of water raised by mills of the same size will be proportionately decreased and the area which can be irrigated will, of course, be decreased in the same proportion. These figures represent not necessarily good practice, but the average results obtained under field conditions. It is probable that in most cases better results than those shown can be secured, but the work this year has been largely to secure a basis for future work by determining what is now being accomplished with windmills.

The average cost shown above is high, and even under the best conditions windmill irrigation is expensive, but it is not expected that water will be raised in this way for general farm crops. The quantities of water required for such crops and the low values of yields will not justify any such expense. Only the irrigation of vegetables and fruits and a small amount of forage is contemplated, and these are all high-priced products. A part of the expense of pumping, on the plains at least, may be charged to insurance against drought, since it is intended to enable farmers to tide over dry years when they would otherwise be compelled to abandon their ranches or buy food for themselves and work animals at exorbitant prices.

Where considerable areas are to be irrigated some other kind of power than windmills will be found better for operating pumps. Investigations of the operation of pumps by means other than windmills were carried on during the past year in California, Texas, Nebraska, Kansas, Colorado, and New Mexico. In all these sections data as to the cost of operating plants now in use were collected, while in California laboratory tests and experiments were made to determine the proper positions for pumps, the most economical speeds, the most economical heads, and other features of the operation of pumps.

Wherever possible, the data given in the reports of the agents of this Office as to the cost of pumping water have been reduced to a form showing the cost of raising 1 acre-foot of water 1 foot. In most instances fuel cost only is given, although in some cases the cost of the attendance and incidental expenses are given. The average cost of raising 1 acre-foot of water 1 foot for 53 pumping plants located in California, Colorado, Kansas, Arizona, and Texas is 3 cents. The average lift for these same plants is 45 feet, making the average cost per acre-foot at the surface of the ground $1.35. This includes several kinds of fuel—wood, coal, distillate, crude oil, gasoline, and electrical power.

Few reports from Colorado, Kansas, and Nebraska have been received as yet. These States are therefore omitted from the averages which follow, as the few plants reported probably do not represent average conditions.

Seventeen plants in California show an average cost of fuel for raising 1 acre-foot 1 foot of 6.6 cents. The average lift is 78.2 feet, making the average cost per acre-foot at the surface of the ground $5.16.

Eight plants in Arizona[a] show an average cost per acre-foot raised 1 foot of 5.3 cents. The average lift is 37.1 feet, giving an average cost of $1.97 per acre-foot of water.

Twenty plants in Texas near El Paso show an average cost per acre-foot raised 1 foot of 4.3 cents, with an average lift of 40 feet.

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[a] Arizona Sta. Bul. 49.

This makes the average cost of water $1.72 per acre-foot. Sixteen plants in the vicinity of San Antonio and to the south and east of that city show an average cost per acre-foot raised 1 foot of 2.6 cents. The average lift is 46 feet and the average cost per acre-foot at the surface $1.20. At Hays, Kans., experiments were begun in 1903 at the substation of the Kansas Agricultural Experiment Station, to test the possibilities of irrigation by pumping. Water was lifted by a centrifugal pump run by a traction engine. In the winter of 1903–4 land was irrigated to test the value of winter irrigation. In the spring of 1904 certain changes were made in the well by which the water supply was increased and through which the cost of raising an acre-foot of water to the ground surface was lowered from $16.92 to $9.36.

These data are brought together in the following table for the purpose of comparison:

*Fuel cost of raising water, by States.*

| Place. | Cost of raising 1 acre-foot of water 1 foot. | Average lift. | Cost of 1 acre-foot of water at ground surface. |
|---|---|---|---|
| | | *Feet.* | |
| California | $0.066 | 78.2 | $5.16 |
| Arizona | .053 | 37.1 | 1.97 |
| Texas: | | | |
| Near El Paso | .043 | 40.0 | 1.72 |
| Near San Antonio | .026 | 46.0 | 1.20 |
| Kansas—Hays | .292 | 32.0 | 9.36 |

Dividing the plants reported on, except the one at Hays, Kans., into groups according to the volume of water discharged by the pumps and averaging the cost of these various groups, gives the following results:

*Cost of raising 1 acre-foot of water 1 foot.*

| Number of plants. | Discharge in cubic feet per second. | Cost per acre-foot raised 1 foot. |
|---|---|---|
| 52 | All sizes | $0.030 |
| 24 | Less than 1 | .094 |
| 19 | 1 and less than 5 | .049 |
| 3 | 5 and less than 10 | .025 |
| 6 | 10 or more | .023 |

This table brings out the great economy in fuel cost of using large plants. It shows that wherever possible farmers will bring about a very great saving in fuel if they join together to install plants to cover several farms instead of maintaining each a separate plant. Professor Fortier, of this Office, estimated that in California the average cost with small individual plants is 1.75 cents per brake horsepower per hour for fuel alone. He estimates that by establishing a central power station on a line of the railroad where fuel can be easily secured, with a steam plant of 2,000 horsepower capacity and with high-grade machinery, the power to be distributed in the form of electrical energy, the entire cost per horsepower-hour at the pump shafts on the different farms should not exceed 66 cents.

The reduction in the cost of attendance with the larger plants as compared with the smaller is even greater than that for fuel. Dividing the plants for which this data is given into groups, as before, we get the following results:

*Cost of attendance on pumping plants per acre-foot of water raised 1 foot.*

| Discharge in cubic feet per second. | Cost per acre-foot of water raised 1 foot. |
|---|---|
| Less than 1 | $0.090 |
| 1 and less than 5 | .039 |
| 5 and less than 10 | .015 |
| 10 or more | .008 |

The rate at which the soil will give up water to a well needs to be investigated thoroughly before putting in a pump. Water may be found at a depth where pumping will be profitable but come into the well so slowly that with a large pump the well will be lowered so far below the normal water level as to double the cost of raising water. Hence the pump must be proportioned to the rate at which water will flow into the well. In one case in Texas, a centrifugal pump, placed at the level of the soil water, when run at its normal speed, lowers the water level 26 feet, thus greatly impairing its efficiency. A much smaller pump would give a better result. At one of the wells in Nebraska a 25-horsepower engine was installed. Water was lifted so rapidly that the well was emptied in two minutes. It is probable that a 5-horsepower engine would have lifted all the water that would flow into the well from the soil. At Hays, Kans., during the first season when the pump ran at full speed, the water level was lowered 14 feet, and the fuel cost of pumping increased 50 per cent. At Redlands, Cal., three wells close together lowered the water 25 feet.

Many makers of pumping machinery will not now install plants until the rate at which water will flow into the well has been thoroughly tested, and then they adjust the capacity of the pump and engine to suit this. The fact that in many soils water flows into wells so slowly makes the windmill, with its limited capacity, the best form of power. It is also probable that the methods adopted in pumping oil, in which a number of pumps are hooked together in a tandem arrangement, will in time be tested.

In answer to many inquiries from farmers regarding the capacity of pumps, tables are given below showing the discharge of pumps of different sizes, and also the areas of land served by these pumps in different parts of the country as determined by observations last year.

*Discharge of centrifugal pumps of different sizes.*

| Size. | Discharge. |
|---|---|
| *Inches.* | *Galls. per minute.* |
| 3 | 221 |
| 4 | 387 |
| 5 | 540 |
| 6 | 896 |
| 10 | 4,185 |
| 12 | 5,157 |
| 30 | 24,975 |

In the section of Texas where a large part of the pumps represented in this table are located, information as to the time of using water and the amount used at each irrigation was collected. This information regarding a few of the more common crops is summed up in the following table:

*Quantity of water used on crops in Texas.*

| Crops. | Time between irrigations. | Depth. | Flow necessary. |
|---|---|---|---|
| | *Days.* | *Inches.* | *Galls. per minute.* |
| Truck or garden | 10 | 2.6 | 5 |
| Corn | 17 | 3.47 | 4 |
| Alfalfa | 15 | 4.13 | 5 |

On the basis of the discharges given above and the practice shown in the last table the areas of these three crops which can be served by pumps of different sizes are shown in the following table:

*Areas served by pumps of different sizes.*

| Size of pump. | Alfalfa or truck. | Corn. |
|---|---|---|
| *Inches.* | *Acres.* | *Acres.* |
| 3 | 44 | 55 |
| 4 | 77 | 97 |
| 5 | 108 | 135 |
| 6 | 179 | 224 |
| 10 | 837 | 1,046 |
| 12 | 1,030 | 1,289 |
| 30 | 4,997 | 6,244 |

## LABORATORY TESTS OF PUMPS.

At the University of California laboratory tests were made for the purpose of determining the conditions of operation under which pumps give the best results. These tests show that for every speed of pump there is a definite head at which the pump works at its highest efficiency, and that for every head there is a definite speed which is most effective for the economical operation of the pump. This was determined by running the pump at different speeds and varying the head until the maximum efficiency was secured. The following table summarizes the test of a No. 4 single-runner horizontal centrifugal pump:

*Heads giving highest efficiency for given rates of speed.*

| Revolutions of pump per minute. | Lowest head. | Highest head. | Head giving highest efficiency. | Efficiency of pump. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Per cent.* |
| 550 | 15.6 | 18.8 | 17 | 63.2 |
| 696 | 20.7 | 30.8 | 25.4 | 67.6 |
| 800 | 26.0 | 39.7 | 28.5 | 69.2 |
| 893 | 32.2 | 52.3 | 40.6 | 70.9 |
| 1,004 | 34.8 | 63.9 | 51.4 | 69.4 |
| 1,102 | 35.5 | 76.1 | 61.3 | 68.9 |

This shows that the maximum working efficiency of this pump occurred when pumping against a head of 40 to 50 feet, with a speed of from 900 to 1,000 revolutions per minute.

Tests made to determine whether the efficiency of a pump working under a definite head and speed is affected by the way in which the head is distributed between the suction and the discharge gave the highest efficiency for the low suction heads, as shown below. This being true with a pump which is well packed, it is obvious that a pump imperfectly packed under a high suction head would perform little useful work.

*Results of tests made to determine effect of changes in suction head.*

| Revolutions of pump per minute. | Discharge head. | Suction head. | Total head. | Efficiency. |
|---|---|---|---|---|
| | *Feet.* | *Feet.* | *Feet.* | *Per cent.* |
| 893 | 23.8 | 16.2 | 40 | 68.3 |
| 893 | 18.9 | 21.1 | 40 | 67.2 |
| 893 | 13.9 | 26.1 | 40 | 66.9 |
| 893 | 9.2 | 30.8 | 40 | 64.4 |

The following results were obtained from a test made of a single-acting, triplex pump of a two-standard style. The efficiency increases rapidly with the head, owing doubtless to the tight packing. The pump was tested in the condition in which it was received from the manufacturer.

*Efficiency of pump under varying head.*

| Speed of pump. | Total head. | Efficiency. |
|---|---|---|
| *Strokes per minute.* | *Feet.* | *Per cent.* |
| 64.8 | 32.4 | 33.8 |
| 64.8 | 76.2 | 54.8 |
| 64.6 | 122.5 | 63.3 |
| 63.4 | 168.5 | 68.4 |
| 64.8 | 215.0 | 71.4 |
| 64.6 | 261.0 | 76.6 |
| 64.5 | 307.2 | 74.5 |

## IRRIGATION IN THE HUMID SECTIONS.

### RICE IRRIGATION.

The water used on several fields in the rice districts of Louisiana and Texas was measured during the seasons of 1903 and 1904, and it is found by comparing the results of these measurements with those made in 1901 and 1902 that the tendency is to use less water than formerly. It is found that a deep covering of water prevents the proper warming of the soil by the sun's rays and produces spindling plants, which are easily blown down by the wind. In many places the rice grown on levees and other high ground is better than that on the lower parts of the fields, where the water stands continuously. For these reasons the tendency is toward the use of less water. This conforms to irrigation practice of northern Italy, where it is seldom that the water covering is more than 2 or 3 inches deep. The following table gives a summary of the measurements of the water used in rice irrigation for four years:

*Summary of results of measurements of the amount of water used in rice irrigation for the years 1901, 1902, 1903, and 1904.*

| Year. | Location of station. | Depth from canal. | Rain-fall. | Total depth. | Evaporation. | Net depth.[a] | Season.[b] | Average evaporation per day. |
|---|---|---|---|---|---|---|---|---|
| | | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Days.* | *Inches.* |
| [c] 1901 | Crowley, La | 16.47 | 10.04 | 26.51 | 14.47 | 12.04 | 63 | 0.230 |
| [c] 1901 | Raywood, Tex | 19.66 | 9.15 | 28.81 | 16.03 | 12.78 | 71 | .226 |
| [d] 1902 | ....do | 19.71 | 11.08 | 30.79 | 11.08 | 13.34 | 91 | .122 |
| [d] 1902 | Lake Charles, La | 23.64 | 7.10 | 30.74 | 11.63 | 19.21 | 77 | .150 |
| 1903 | Estherwood, La | 12.67 | 19.00 | 31.67 | 15.69 | 15.98 | 98 | .160 |
| 1903 | Eagle Lake, Tex | 7.37 | 13.46 | 20.83 | 9.83 | 7.56–11.32 | 84 | .117 |
| 1904 | Estherwood, La | 5.01 | 18.52 | 23.53 | 14.91 | 8.62 | 91 | .164 |
| 1904 | Crowley, La | 5.44 | 20.54 | 25.97 | 13.30 | 12.68 | 98 | .136 |
| 1904 | Nottoway, Tex | 14.12 | 19.97 | 34.09 | 18.25 | 15.84 | 119 | .153 |
| | Average | 13.79 | 14.32 | 28.10 | .......... | [e] 13.32 | .......... | .162 |

[a] Water absorbed by soil and taken up by rice plants.
[b] Number of days in which rainfall and evaporation were measured.
[c] U. S. Dept. Agr., Office of Experiment Stations Bul. 113.
[d] U. S. Dept. Agr., Office of Experiment Stations Bul. 133.
[e] Using the mean of No. 6.

### ANALYSES OF WATER USED IN RICE IRRIGATION.

Many of the streams along the Gulf coast have so little fall that a slight lowering of the water by pumping produces an inflow of salt water from the Gulf. This inflow of salt water begins long before the supply of fresh water is exhausted. In 1902 a drought lowered the water level in the river and large quantities of salt water were run on the rice fields in their irrigation. It was found that young plants were killed by this salt water, but fields which had made a good growth were benefited by its use. It was feared, however, that the use of this salt water would bring about an accumulation of salt in the soil which would prove harmful in the future. The results of 1903 and 1904 have proved this fear to be groundless. The heavy rains of those years have so thoroughly washed out the salt that no difference could be observed between the fields irrigated with salt water in former years and those which have received none but fresh water. It is not considered advisable, however, to use salt water except in cases of extreme necessity.

A number of samples of water used for rice irrigation were analyzed to determine their salt content. The results of these analyses follow.

*Water analysis for irrigation investigation.*

[Parts per million.]

| Laboratory No. | Location. | $SiO_2$. | $SO_4$. | $HCO_3$. | Cl. | Ca. | Mg. | K. | Na. |
|---|---|---|---|---|---|---|---|---|---|
| 1873 | Halfway between Lowry and Houckts, La | 9.0 | 263.7 | 30.3 | 1,846.0 | 46.4 | 110.9 | 35.7 | 1,048.0 |
| 1874 | Center of Grand Lake, La | 8.0 | 327.2 | 30.3 | 2,237.5 | 52.1 | 146.7 | 32.2 | 1,259.9 |
| 1875 | Sea side of Mermentau dam | 6.8 | 1,799.2 | 146.7 | 12,306.0 | 297.1 | 832.4 | 231.4 | 6,886.4 |
| 1876 | Lower end of Grand Lake, La | 8.0 | 363.9 | 33.3 | 2,535.4 | 46.4 | 162.9 | 53.6 | 1,434.7 |
| 1877 | Upper side of Mermentau dam | 7.0 | 979.6 | 95.4 | 8,552.0 | 222.1 | 591.8 | 165.7 | 4,536.4 |
| 1878 | Center of Lake Arthur, La | 11.6 | 247.2 | 27.2 | 1,704.0 | 42.1 | 105.2 | 38.8 | 961.9 |
| 1879 | Mermentau Bayou, Mermentau, La | 14.0 | 87.7 | 27.2 | 781.0 | 27.9 | 46.7 | 21.5 | 429.7 |
| 1880 | Upper end of Grand Lake, La | 8.2 | 290.1 | 30.3 | 1,974.9 | 52.9 | 126.2 | 32.2 | 1,110.0 |
| 1881 | Center of Mud Lake | 10.8 | 966.3 | 99.2 | 6,557.0 | 171.4 | 439.4 | 129.6 | 3,908.3 |
| 1882 | Mermentau Bayou, mouth Bayou Quene de Tortue | 15.2 | 90.7 | 36.3 | 710.0 | 22.9 | 44.3 | 14.2 | 398.2 |
|  | Bayou Quene de Tortue at Lichtenstein plant: |  |  |  |  |  |  |  |  |
| 1885 | 6 feet | 12.0 | 197.0 | 15.1 | 1,455.5 | 50.0 | 98.2 | 29.4 | 781.5 |
| 1886 | 20 feet | 10.6 | 193.7 | 18.2 | 1,349.0 | 41.4 | 82.9 | 29.4 | 763.0 |
| 1883 | Well, sec. 10, T. 11, R. 7 | 15.4 | 101.0 | 284.6 | 57.0 | 46.4 | 19.4 | 3.1 | 100.2 |
| 1884 | English Bayou | 18.0 | 9.0 | 39.4 | 14.0 | 5.7 | 6.5 | 2.6 | 7.5 |
|  | From J. A. Myers, Gueydan, La.: |  |  |  |  |  |  |  |  |
| 2024 | 4 feet | 6.7 | 4.0 | 24.2 | 80.0 | 8.6 | 5.7 | 4.2 | 39.6 |
| 2025 | 21 feet | 6.5 | 3.5 | 24.2 | 80.0 | 6.4 | 5.4 | 4.0 | 42.7 |

| Laboratory No. | Location. | Hypothetical combination. |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  |  | $Ca(HCO_3)_2$. | $CaSO_4$. | $MgSO_4$. | $MgCl_2$. | NaCl. | KCl. | $SiO_2$. |
| 1873 | Halfway between Lowry and Houckts, La | 40.2 | 124.1 | 220.1 | 264.5 | 2,664.0 | 68.1 | 9.0 |
| 1874 | Center of Grand Lake, La | 40.2 | 143.5 | 282.4 | 356.5 | 3,201.8 | 61.5 | 8.0 |
| 1875 | Sea side of Mermentau dam | 194.8 | 846.8 | 1,502.0 | 2,103.6 | 17,500.5 | 441.7 | 6.8 |
| 1876 | Lower end of Grand Lake, La | 44.2 | 120.7 | 348.4 | 368.5 | 3,646.0 | 102.4 | 8.0 |
| 1877 | Upper side of Mermentau dam | 126.7 | 648.7 | 652.1 | 1,824.5 | 11,604.7 | 316.3 | 7.0 |
| 1878 | Center of Lake Arthur, La | 36.1 | 112.9 | 209.4 | 249.5 | 2,444.4 | 74.1 | 11.6 |
| 1879 | Mermentau Bayou, Mermentau, La | 36.1 | 64.6 | 52.6 | 143.1 | 1,079.3 | 41.0 | 14.0 |
| 1880 | Upper end of Grand Lake, La | 40.2 | 146.2 | 233.6 | 314.3 | 2,820.8 | 61.5 | 8.2 |
| 1881 | Center of Mud Lake | 131.7 | 472.3 | 791.1 | 696.5 | 9,932.2 | 247.4 | 10.8 |
| 1882 | Mermentau Bayou, mouth Bayou Quene de Tortue | 48.2 | 37.4 | 80.4 | 111.5 | 1,012.0 | 27.1 | 15.2 |
|  | Bayou Quene de Tortue at Lichtenstein plant: |  |  |  |  |  |  |  |
| 1885 | 6 feet | 20.1 | 153.0 | 111.3 | 300.1 | 1,986.1 | 56.1 | 12.0 |
| 1886 | 20 feet | 24.2 | 95.4 | 167.1 | 195.7 | 1,939.1 | 56.1 | 10.6 |
| 1883 | Well, sec. 10, T. 11, R. 7 | 187.9 | ........ | ........ | ........ | 89.4 | 5.9 | 15.4 |
| 1884 | English Bayou | 23.1 | ........ | 11.2 | ........ | 19.1 | 5.0 | 18.0 |
|  | From J. A. Myers, Gueydan, La.: |  |  |  |  |  |  |  |
| 2024 | 4 feet | 32.1 | 2.4 | 2.9 | 20.2 | 100.7 | 8.0 | 6.7 |
| 2025 | 21 feet | 25.9 | ........ | 4.4 | 14.2 | 108.5 | 7.6 | 6.5 |

These analyses were made under the direction of Mr. J. K. Haywood, chief of the insecticide and water laboratory of the Bureau of Chemistry. A letter from Mr. Haywood respecting the interpretation of these analyses says:

> The approximate quantity of the various salts, especially sodium chlorid, which are injurious to rice has not, to my knowledge, been determined. It is well known that rice can stand more sodium chlorid than most crops, but how much more I am unable to state. I can therefore only give you interpretations based on the action of irrigation waters upon crops in general, and for this purpose will divide the waters into those that I am reasonably sure are very poor, those that are surely good, and those which under some circumstances might be good and under other circumstances bad.
>
> I would say that the salt content of waters 1873, 1874, 1875, 1876, 1877, 1878, 1880, 1881, 1885, and 1886 is such that they would be pretty sure to cause trouble in a comparatively short time. Waters 1883, 1884, 2024, and 2025 could be used, especially in a moderately humid climate, without any fear of damage to crops. Waters 1879 and 1882 could very likely give good results in a moderately humid climate and on a light, loose soil, but in a very dry climate or upon a heavy clay soil they might cause damage in the course of time.
>
> You of course understand that the above remarks only apply to these waters as they would be used in general irrigation practice. What effect the rains, which are to be expected in a climate like Louisiana, would have upon relieving the evil conditions caused by such waters as I have indicated as "poor" above, I am unable to state.

On the Mermentau River an attempt has been made to improve the water supply by damming out the salt water during the times the river is lower than the water in the Gulf and holding up the fresh water when the flow is toward the Gulf. The dam on the Mermentau was completed during the season of 1904, and to its existence is attributed the saving of the crop, as salt water entered the other streams so early as to make it impossible to secure sufficient fresh water for the complete irrigation of the rice.

The construction of this dam has called attention to the need of laws for the assessment of the cost of such works against those benefited. As originally planned, the Mermentau dam was to be paid for by voluntary subscription, but, as is usual in such cases, a number of parties benefited have refused to contribute to its cost. The estimated cost was greatly exceeded, and it was found impossible to raise the money by voluntary subscriptions. An appeal was made to the legislature of the State of Louisiana, and an act passed which created a board of commissioners for the Mermentau levee district, authorizing the following taxes: A tax of 2.5 cents per sack of rice raised by means of water from the Mermentau and its tributaries, and a similar tax on cotton, sugar, fruit, etc.; a tax of 10 mills on all property subject to taxation for levee purposes, the tax not to exceed 2.5 cents per acre on all lands subject to irrigation within the levee district, and $50 per mile for all standard-gauge railroads within the district.

Common carriers were prohibited from receiving or removing produce on which the taxes were not paid. The law authorized the board of commissioners to issue bonds to the amount of $200,000 to be used for work done or in the purchase of levees, locks, and dams within the district. A commission was appointed, but has never met. An injunction has been granted enjoining the board from performing any of the functions or exercising any of the powers conferred upon it by law or in any way attempting to carry into effect the provisions of the law. It would seem that some general law providing for the organization of districts similar to irrigation or drainage districts in other States would be preferable to such special laws as this. In such districts in other States only the tax on land is levied and only such a tax is considered good security for the bonds issued. The passage of such a district law, under which the cost of dams to keep out the salt water and other improvements could be equitably assessed against the lands benefited, would greatly promote the rice industry by putting within the reach of those communities a convenient means of raising money for the construction of these works.

The success of rice growing in Louisiana and Texas has led to experiments in its culture in other sections, particularly in the State of Arkansas. This State contains large areas of level prairie lands which have not been successfully farmed with other crops. They are very wet during the spring, but during the late summer and fall are very dry. For several years farmers in the vicinity of Lonoke have been experimenting with rice, and during the season of 1904 this Office, in cooperation with the Arkansas Experiment Station, conducted an experiment in the vicinity of Lonoke to determine the possibility of profitably raising rice on the prairie lands. Ten acres were broken up and prepared for planting, a well was dug, and a pumping plant purchased and installed.

An 8-inch well was sunk on the experimental plat. Water was struck at a depth of 70 feet and the well penetrated the water-bearing strata 44 feet, making the total depth of the well 114 feet. The water rose to within 27 feet of the surface and was lowered but little by pumping, showing that there is a good supply at this depth. The well cost $4 per foot, including casing and strainer, making the total cost $456. The pumping plant consisted of a 20-horsepower boiler and an 18-horsepower throttling center-crank engine and a No. 4 centrifugal pump. These, with all the accessories, cost $858.59. The shed covering the pumping machinery cost $90, making a total cost of $1,404.59. Eight acres were planted and watered. Owing to the wet spring a part of this land was seeded so late that the crop did not mature, and part of that which did mature did not fill properly.

The crop from 3 acres was not thrashed, and that from 5 acres was poorly thrashed, owing to trouble with the machinery. The average yield estimated from the part of the crop which was thrashed was 64.6 bushels per acre. Those in charge of the experiment are of the opinion that in irrigating the rice some mistakes were made, accounting in part for the poor yield. It is hoped that a continuation of the experiment through another year will give more satisfactory results.

Mr. W. H. Fuller has put in a pumping plant for the irrigation of rice near Carlisle, Ark. Mr. Fuller has a 10-inch well 140 feet deep, a 6-inch centrifugal pump, operated by a 25-horsepower engine, and a 35-horsepower boiler. The cost of Mr. Fuller's plant was as follows:

*Cost of pumping plant of W. H. Fuller.*

| | |
|---|---|
| Pumping plant and accessories and well | $1,782.35 |
| Rice binder | 135.00 |
| Total investment | 1,917.35 |
| The annual expense for pumping plant, including fuel, oil, repairs, and attendance | 405.40 |
| Field expenses, including plowing, seed, seeding, harvesting, thrashing, etc | 804.75 |
| Interest on investment | 134.21 |
| Total | 1,344.36 |

This pumping plant served 70 acres during the season of 1904. The investment therefore amounted to $27.39 per acre, and the annual expense was $19.21 per acre. The plant is considered sufficiently large to serve 100 acres, and on this basis the investment is $19.17 per acre, and the annual expense $13.44 per acre. The yield of 70 acres planted in 1904 was 5,225 bushels, or 74.6 bushels per acre. The cost of raising 1 bushel of rice was therefore 26 cents.

## CRANBERRY IRRIGATION.

In cooperation with the Wisconsin Experiment Station, this Office in 1904 worked to determine the relations of frost to water conditions in the cranberry marshes of Wisconsin. The United States Weather Bureau has established stations in the cranberry-growing region for the purpose of predicting frosts, and this Office is at work to determine the measures of protection needed when frosts occur.

The experiments of the past year included treatment of the soil, drainage, and irrigation. It was found that on land which was well sanded temperatures remain much higher during cold nights than over undrained sections of bogs. This was strikingly illustrated during the month of August. Over the undrained bogs the temperature went to freezing or below, while on the sanded places it was nowhere less than 34° above, as will be seen by the following table:

*Temperatures over ordinary bog and sanded plats during August, 1904.*

| Day of month. | Ordinary bog. | Sanded plats. |
|---|---|---|
| | *° F.* | *° F.* |
| 2 | 32.0 | 43.0 |
| 8 | 26.0 | 34.0 |
| 22 | 30.5 | 40.0 |
| 23 | 30.0 | 37.0 |
| 26 | 32.0 | 36.5 |
| 30 | 28.5 | 37.0 |

The following table, giving hourly temperatures on drained and undrained bogs during the night of August 22–23, shows the effect of drainage in preventing frost:

*Temperatures over drained and undrained bog.*

| Hour. | Drained plat. | Ordinary bog. |
|---|---|---|
| | *°F.* | *°F.* |
| 9.30 p. m | 42.0 | 33.5 |
| 10.30 p. m | 39.5 | 33.3 |
| 11.30 p. m | 38.0 | 31.5 |
| 12.30 a. m | 37.5 | 30.0 |
| 1.30 a. m | 36.3 | 29.7 |
| 2.30 a. m | 35.5 | 32.5 |
| 4.30 a. m | 34.0 | 38.5 |

While sanding and draining tend to keep up the temperature over bogs, the only sure protection against frost is flooding. Where vines are flooded they are apt to be injured unless the water is drawn off quickly when the temperature rises. Hence effective frost protection requires such control of the water supply as will permit of the quick flooding of vines when cold weather sets in and the quick and complete removal of water when it ends. The work of this Office is being directed to working out the proper arrangement and size of supply and drain ditches to accomplish this result.

The water for flooding cranberry marshes is secured principally by storage, and this storage is accomplished chiefly by building dams or dikes across the slope to hold the water from larger areas of marsh above. These dams are usually constructed of peat, taken from the adjacent bog, and sand when it can be found within hauling distance. A dam of this kind 18 feet wide at the base, 10 feet wide at the top, and 4.5 feet high, was constructed at an expense of $3.95 per running rod. This dam later had a sand facing put on it at an expense of approximately $2 per running rod. A part of the peat used in the construction of the dam was taken from the inside of the reservoir, but it was found that removing the peat greatly increased losses from seepage.

The slope of the marshes is naturally slight, and the reservoirs created by building dikes across the slope are shallow, and there are great losses from evaporation. The loss from this cause during June and July, 1904, amounted to 13.82 inches, or a lowering of the water level during the season of between 1 and 2 feet. This large evaporation from a reservoir having an average depth of not more than 2 or 3 feet means the loss of a very large proportion of the total supply. The growing of vegetation within the reservoir is considered by some as a protection against this loss, but it is probable that the water given off by the levees is equal to that which would be lost from an open-water surface. Increasing the depth of reservoirs decreases the percentage of loss by evaporation, but in the sandy soils of this region it is apt to increase the losses by seepage. Some practical method of checking seepage losses will be of great help to water storage in the cranberry districts.

### IRRIGATION IN PORTO RICO.

In the southern and southeastern portions of the island of Porto Rico irrigation is necessary to the raising of crops, and in many sections irrigation systems can be installed at a small outlay. In those sections irrigation will doubtless soon become an important factor in agriculture.

In the greater part of the island the rainfall is ordinarily sufficient for crops, but almost every year there is a period when the growth of crops, especially vegetables, fruits, and sugar cane, is checked by lack of sufficient rainfall. In cooperation with this Office the Porto Rico Experiment Station is testing irrigation on a part of the station farm at Mayaguez. This farm had previously been irrigated, there being remains of a diverting dam and of ditches covering the land. In 1904 experiments were made in the irrigation of sugar cane, grapes, tomatoes, eggplant, celery, cabbage, melons, and other truck crops. Ground has been prepared for the irrigation of lowland rice. Thirty or forty acres will be irrigated when the system is completed. Several sugar growers on the island have signified a desire to cooperate in experiments in the irrigation of sugar cane, and during the coming year such experiments will be carried on.

## LAWS AND INSTITUTIONS RELATING TO IRRIGATION.

The study of irrigation from the Platte River and its tributaries, from an interstate standpoint and as illustrating the operation of "laws affecting irrigation and the rights of riparian proprietors and the institutions relating to irrigation," begun in 1903, was completed in 1904. The report of this work is an exhaustive study of the laws and decisions of the States of Colorado, Wyoming, and Nebraska. It gives the complete statement of the rights to these streams established in these States.

The physical conditions which have an influence on these rights were also studied. The general conclusion reached regarding the interstate feature of irrigation from the Platte is that thus far the use of this stream in Colorado and Wyoming has not materially injured Nebraska. On the contrary, continued irrigation in Colorado has brought about an improvement in the conditions on the lower South Platte in that State by rendering the flow more uniform. This improved condition is gradually progressing downstream and has now reached nearly to the Colorado-Nebraska line. If this increase in the midsummer flow of the river due to return seepage continues to extend downstream, in a few years the South Platte in Nebraska will furnish a better irrigation supply than it ever has before, and irrigation in Colorado will have proven a benefit to Nebraska rather than a detriment. Conditions on the North Platte are somewhat different from those on the South Platte. The nature of country through which the river flows is such that very little use has been made of the stream in Colorado and Wyoming, and the principal development has been in Nebraska. There is, however, opportunity to divert the water of the North Platte in Wyoming directly above the Wyoming-Nebraska line, and such development might injure users in Nebraska. The courts of Nebraska and Wyoming have held that prior rights should be protected regardless of State lines, but the holders of these rights have now no means of protection except through the courts. What is needed, therefore, is some executive officer or commission with interstate powers through whom water users in one State can secure protection against those in another without going to the courts.

The situation on the Platte River was also studied from the economic standpoint by an agent of this Office. The report of this agent calls attention to the dangers of water monopoly and the necessity for public control of water. The report also calls attention to the lack of a harmonious system and the waste attending a strict enforcement of priorities. For the creation of a harmonious system which would do away with this waste, the report recommends the extension of the right of eminent domain in order that early rights, the satisfaction of which requires the wasteful use of water, may be condemned for the sake of securing a larger use. The report also calls attention to the need of some administrative control, so that it will not be necessary to resort to the courts every time a controversy arises.

Interstate controversies have also arisen on the Raft River, in Utah and Idaho. The courts of both Utah and Idaho are committed to the doctrine that rights must be enforced regardless of State lines, but here, as on the Platte River, there is need of interstate administrative control.

Some of the administrative features of the Idaho law of 1903 were studied during 1904. An agent of this Office was appointed water master on Raft River and made this study of the law from the standpoint of one charged with its enforcement. He found the greatest drawback in his work to be the absence of proper measuring devices. The law provides for the placing of such devices by ditch owners, and, further, that in case the ditch owners neglect to provide these the water commissioner shall put them in and collect the cost from the county commissioners, who in turn collect it from the ditch owner. This course places a large expense upon the water commissioner, and in addition he must take the chance of having his bills disallowed by the county commissioners for some reason or other, so that he is obliged to carry this expense for long periods and sometimes is unable to reimburse himself. It is recommended that the law be amended so as to relieve the water commissioner of this burden and yet leave him with power to enforce the putting in of measuring devices.

Other unsatisfactory conditions were found on Raft River. Parties who had been decreed definite volumes of water had organized a company. They did not need all the water decreed to them, and in the form of this company had disposed of it to others who were not parties to the decree. In this way the law requiring that water not needed by those to whom it was decreed be turned down the stream is being evaded. Either the law should be enforced or should be amended in such a way as to promote economical use rather than encourage waste. On another section of this same stream parties were wasting water in the sagebrush to keep it from flowing down to lower users in order that those wasting the water might maintain their rights to the full quantity. Such waste is contrary to law, but the present system of water rights seems to encourage, if not actual waste, a wasteful use in order that water-right holders may maintain their rights to large supplies.

In certain irrigation districts in California studies were made for the purpose of working out a system of distributing water belonging to the districts among those entitled to it. As a first step in working out such systems, records of the quantities of water delivered to the users were kept during 1904 by the agent of this Office, and on his recommendation the districts have adopted a system for keeping records of the flow of water distributed to each user and the time during which the water is used. The California district law provides that the water be distributed "ratably to each landowner upon the basis of the ratio which the last assessment of such owner for district purposes within said district bears to the whole sum assessed upon the district." It is not at all likely that such a system can be followed and it is recommended in the report on the Modesto and Turlock districts that this law be put to the test now while not enough land is watered to make a heavy demand on the water supply. If the law can not be enforced, it should be amended before serious difficulty has arisen. Water is now distributed in these districts on a time schedule based on the acreage irrigated.

The organization of the farmers under different laterals for controlling the water belonging to them is also recommended. Such local management of laterals or branch canals has proved very satisfactory in some sections of this and other countries, and it is believed that much good may be accomplished by its general adoption.

The laws of the several States creating the office of State engineer have been studied and data have been collected for the preparation of a report showing the operation of these laws and comparing their efficiency.

Large diversions from the streams of Louisiana and Texas for rice irrigation have called attention to the inadequacy of the water laws of these States, and an agent of this Office has been for two years past studying the systems of these States for the purpose of recommending necessary changes in their laws. The report of this work is now in preparation.

## DRAINAGE INVESTIGATIONS.

### SCOPE OF THE WORK.

In recognition of the importance of the drainage work of this Office, Congress at its last session changed the title from "Irrigation Investigations" to "Irrigation and Drainage Investigations." The need of this added work on drainage is shown by the fact that there are in the humid sections of this country probably 100,000,000 acres of land too wet for profitable cultivation, while probably one-half of the land now cultivated would be more productive if properly drained. In addition, large areas in the arid region have become too wet or too strongly alkaline for crop production, due to leakage from canals and excessive use of water in irrigation. The reclamation of these wet lands in both the humid and arid sections depends upon the adoption of correct methods of drainage, and their drainage within the limits of profitable cost requires that the correct methods be arrived at by investigations rather than through costly failures.

The drainage work of this Office consists of the employment of drainage engineers of large experience, who spend their time in working out the best methods of drainage and in making the knowledge gained by them available for the owners of wet lands, through personal advice and the publication of practical bulletins. This work includes the questions relating to the drainage of individual farms as well as those relating to the larger projects requiring the united action of many farmers.

The investigations of the year with respect to the kind of work pursued may be classified as follows:

(1) An examination of some of the irrigated lands of Utah, for which drainage is urgently needed and concerning which plans and advice were given.

(2) Experimental work in Cache County, Utah, in cooperation with the farmers and the State station, this being the first work of the kind attempted by this Office.

(3) The measurement and recording of the fluctuation of ground water in representative irrigated sections where drainage is required.

(4) The examination of large drainage projects in the Middle West, in company with engineers, county boards, and interested landowners, followed by reports and recommendations regarding the best plans.

(5) Collecting and classifying field data upon the construction of levees for the protection of river-bottom lands and their ditching and draining by pumps; the construction and use of automatic sluice gates; the protection of level lands from high water; the construction, duty, and operation of land dredges for excavating new drainage ditches and repairing and cleaning out old ones, and the cost and behavior of drainage ditches of various sizes and materials.

(6) The examination of a portion of the State of Indiana with reference to the older systems of tile drainage, which in some instances are being reconstructed. The purpose was to ascertain how the work was originally done and its effects upon the land, why and in what respects the changes now going on are being made, the cost of the same, and the advantages which the farmers expect to gain by reconstruction.

The projects in the Middle West which have been examined upon request are districts which the promoters desire to organize in accordance with the laws of the respective States. Preliminary plans are important in all such cases and require careful consideration. The following projects have been made the subject of personal examination and report:

Coon River district, Buena Vista County, Iowa: Watershed to be provided for, 128,000 acres; area of land directly affected, 25,000 acres; estimated cost, $150,000.

Soldier River improvement, Harrison County, Iowa: Area benefited, 32,640 acres; estimated cost, $111,000.

Burt County district, Nebraska: Area benefited, 42,906 acres; estimated cost, $98,000.

Nemaha River improvement, Richardson County, Nebr.: Area of watershed to be provided for, 1,000,000 acres; land affected by the drainage, 30,000 acres; estimated cost, $205,000.

Clay and Yankton counties drainage improvement, South Dakota: Area affected, 70,000 acres; estimated cost, $224,000.

Dancy drainage district, Marathon and Portage counties, Wis.: Area affected, 32,000 acres; estimated cost, $192,000.

These drainage projects present a variety of problems, each one differing from the others in many essential particulars. The ultimate object of the work in every case is to devise and recommend a plan which, when carried out in full, will so drain the land as to fit it for the production of the crops to which the soil and climate are adapted.

A preliminary examination of a portion of the Everglades in Dade County, Fla., was made in conjunction with the Bureau of Plant Industry. It is thought that the Everglade soil can be made profitable for growing subtropical fruits if it can be sufficiently drained.

No attempt will be made to give here complete results of the work of the season of 1904, but that done in certain localities will be described in detail, illustrating the general lines along which work is being done.

## THE ARID REGION.

In the humid sections of this country drainage is employed to remove water coming from rainfall or overflowed streams, and the question is, how best to remove or keep off this surface water. In the arid region the problem is entirely different. There the surplus water comes from ditches by seepage or from overwatered lands, usually from the lands needing drainage. This water does not come on the surface, but rises from below, the plane of saturation gradually rising until water is so near the surface as to kill vegetation, or perhaps actually stand on the surface. This rising ground water usually brings with it the soluble salts of the soil, which are deposited on or near the surface as the water evaporates. Drainage in the irrigated sections has, therefore, the double purpose of removing surplus water and preventing the harmful accumulation of alkali. It serves the further purpose of making it possible to wash out alkali where it has already accumulated.

## KEEPING RECORDS OF THE RISE OF GROUND WATER.

In the arid region the water which ruins lands and should be removed by drainage comes from below. Its approach is, therefore, usually unnoticed until crops begin to suffer. This rise of ground water can easily be detected by the aid of test wells put down in various parts of irrigated fields, and such wells have been put down in a number of irrigated sections. In these wells the water rises to the same height as the plane of saturation in the soil, so that a measurement from the surface of the ground to the surface of the water in the well at any time will show how far the ground water is below the surface. The rate of the rise of water in these wells furnishes data for computing the quantity of water which must be removed by drainage in order to keep the ground water at any desired distance below the surface. Such well records are being kept at Fresno, Cal.; Sunnyside, Wash.; Billings, Mont.; Reno, Nev.; Logan and other points in Utah. The distance to the surface of the water in these wells is measured once a week or oftener. The records of these measurements show the rate of rise of the ground water throughout the irrigating season. It is estimated that water which should be removed from saturated soil to restore it to proper condition for plant growth is 30 per cent of the volume of the saturated soil. That is, if it is desired to lower the ground water 12 inches, it will be necessary to remove water to cover the area drained to a depth of 3.6 inches, or 30 per cent of 12 inches. The average daily rise of ground water in the Fresno district for March 17 to June 2, when the ground water began to fall, is shown in the following table. The last line of the table shows the depth of water which it would be necessary to remove daily in order to prevent this rise of the ground water.

*Fluctuation of water table at Fresno, Cal., March 17 to June 2, 1904.*

| | Mar. 17 to Apr. 3 (17 days). | Apr. 3 to May 5 (32 days). | May 5 to June 2 (28 days). |
|---|---|---|---|
| Well No. 1: | *Inches.* | *Inches.* | *Inches.* |
| Total rise | 12.0 | 11.0 | 4.25 |
| Average daily rise | .705 | .343 | .152 |
| Well No. 2: | | | |
| Total rise | 11.0 | 5.0 | 5.50 |
| Average daily rise | .647 | .156 | .196 |
| Well No. 3: | | | |
| Total rise | 11.50 | 2.50 | 7.0 |
| Average daily rise | .676 | .078 | .250 |
| Well No. 4: | | | |
| Total rise | 11.75 | 10.75 | .000 |
| Average daily rise | .691 | .335 | .000 |
| Well No. 5: | | | |
| Total rise | 12.0 | 9.50 | 1.50 |
| Average daily rise | .705 | .297 | .057 |
| Well No. 6: | | | |
| Total rise | 34.50 | 12.75 | [a]1.50 |
| Average daily rise | 2.029 | .398 | [a].057 |
| Well No. 7: | | | |
| Total rise | 6.50 | 12.50 | 6.50 |
| Average daily rise | .382 | .291 | .233 |
| Average daily rise | .832 | .271 | .113 |
| 30 per cent average daily rise drainage | .249 | .081 | .034 |

[a] Fall.

The following table shows the fall of the ground-water level after June 2:

*Fluctuation of water table at Fresno, Cal., from June 2 to September 1, 1904.*

| | June 2 to July 7 (35 days). | July 7 to Aug. 4 (28 days). | Aug. 4 to Sept. 1 (26 days). |
|---|---|---|---|
| | *Inches.* | *Inches.* | *Inches.* |
| Well No. 1: | | | |
| Total fall | 1.75 | 8.50 | 13.0 |
| Average daily fall | .033 | .305 | .500 |
| Well No. 2: | | | |
| Total fall | 19.50 | ......... | ......... |
| Average daily fall | .556 | ......... | ......... |
| Well No. 3: | | | |
| Total fall | 20.50 | ......... | ......... |
| Average daily fall | .585 | ......... | ......... |
| Well No. 4: | | | |
| Total fall | 13.75 | 7.0 | ......... |
| Average daily fall | .393 | .250 | ......... |
| Well No. 5: | | | |
| Total fall | 9.50 | 7.25 | 14.75 |
| Average daily fall | .271 | .259 | .567 |
| Well No. 6: | | | |
| Total fall | .75 | 4.75 | 9.75 |
| Average daily fall | .022 | .170 | .357 |
| Well No. 7: | | | |
| Total fall | 5.0 | .75 | 11.75 |
| Average daily fall | .143 | .026 | .457 |
| Average daily fall | .283 | .144 | .267 |

Water was turned into irrigation canals the first week in January and turned out the second week in September.

The rise of the soil-water level is shown graphically in figure 1. The average daily rise from March 17 to April 3 was 0.832 foot, and in order to prevent this rise it would be necessary to remove by drainage 0.249 inch in depth from the land per day, or 6.4 cubic feet per second for each square mile of territory drained. From April 3 to May 5 the average daily rise was 0.271 inch, and it would be necessary to remove 0.081 inch per day in order to prevent the rise of the ground water. From May 5 to June 2 there was a daily rise of 0.113 inch, and it would be necessary to remove 0.034 inch to prevent the rise. The plans submitted for the drainage of this area provided for the removal of enough water to cover the land to a depth of 0.093 inch per day. This would not entirely prevent the rise of the water during the month of March, but is more than sufficient to overcome the rise for the remainder of the season and would soon overcome the rise of March.

The soil in the Fresno district is so open that the water would readily reach the drains if they were provided, with the exception of areas where hardpan is found. In ordinary years drainage will not be required after June 10, as the water then begins to decline and reaches the bottoms of the 8-foot wells in September. In view of these conditions, drainage by pumping is practicable, since pumps will need to be operated only during a short time. This system can be used for the relief of one or more farms in case a general system is not adopted. A single well in which drains from one or more

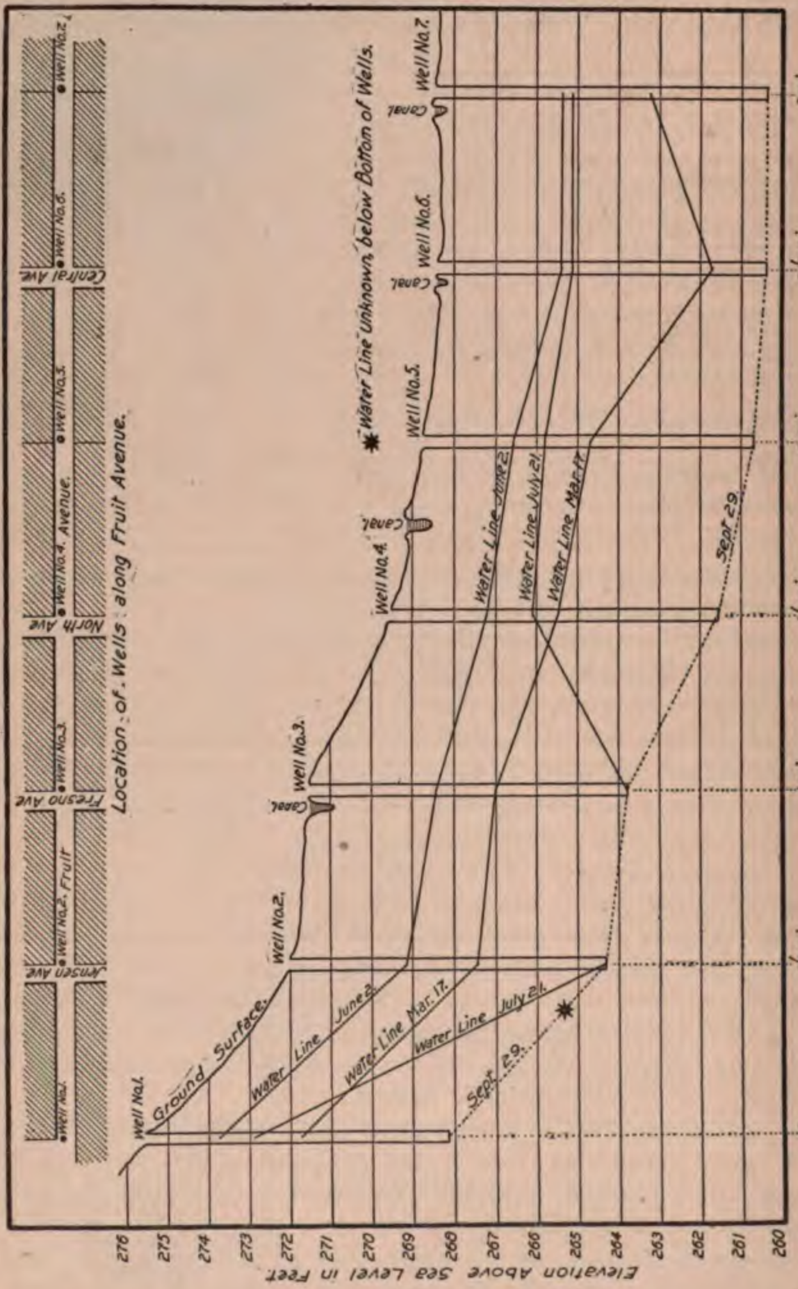

FIG. 1.—Diagram showing rise of seepage water in soil along Fruit avenue, near Fresno, Cal., during irrigation season of 1904.

farms empty may be pumped by the owners. Adjoining lands would be benefited by such work, and without some district organization these lands could not be made to contribute to the expense of pumping.

Similar well measurements were made on the Nevada Experiment Station farm at Reno. These measurements, as platted, are shown in

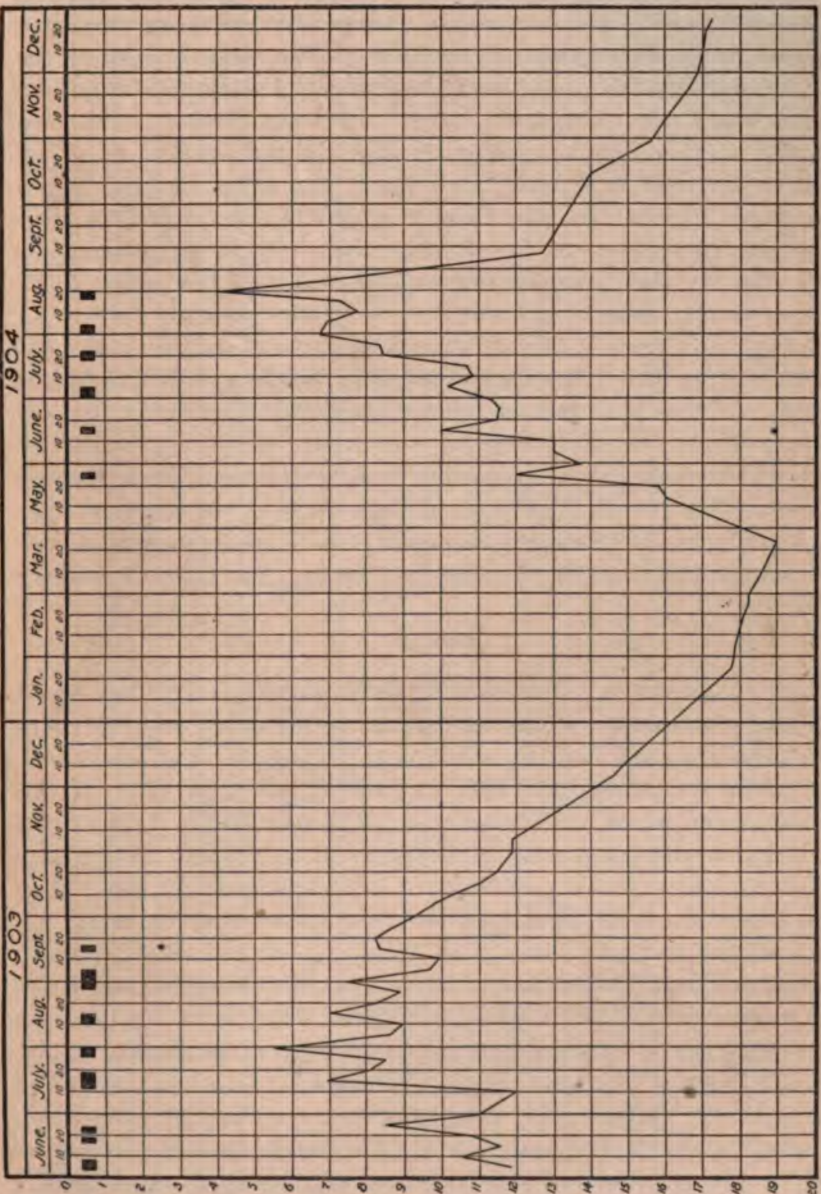

FIG. 2.—Diagram showing influence of irrigation on the soil-water level at the experiment station farm at Reno, Nev., in 1903 and 1904.

figure 2. The line across the diagram shows the fluctuations of the ground-water level, and the small black areas at the top of the diagram show the dates when water was applied to the field where the well is located. The diagram does not show the dates of irrigation on surrounding lands, but water was used continuously on these lands from May to September. The diagram shows that there was a general rise in the ground-water level from May to September, due to irrigation in the region of the experiment station farm, and that there were local rises on the plat where the well was located in response to each irrigation of this field. The most important feature brought out by these measurements is the rapid fall of the ground water when irrigation ceases. Previous measurements show that the average quantity of water used in this section is enough to cover the land to a depth of 7 feet. The subsoil in this region is composed of bowlders, and there is a heavy slope toward the river. These conditions account for the fact that such large quantities of water can be used without detrimental results. The same conditions, however, make it necessary to use large quantities of water, since the water used so quickly goes down beyond the reach of plant roots. During the irrigating season of 1904 the ground water rose 15 feet. If this land had an impervious subsoil within a few feet of the surface, the prevention of swamping would require the removal by drainage of water enough to cover the land to a depth of 4.5 feet. This rise occurred during the period of one hundred days, and to remove this water by drainage would have required ditches with a capacity of 14.5 cubic feet per second for each square mile of territory.

### UTAH.

There is scarcely an irrigated valley in the State of Utah which has been cultivated for a term of years in which some of the best land has not become too wet for cultivation. Therefore the cooperative arrangements between this Office and the Utah Experiment Station include drainage as well as irrigation investigations. The work has included the examination of typical valleys where the damage has been greatest and experiments in drainage in the Cache Valley, in the immediate neighborhood of the Utah Experiment Station.

One of the sections which is in most urgent need of drainage is the Virgin River Valley in the vicinity of St. George. A tract of land in this vicinity was examined in June, 1904, to determine what was needed for its reclamation. This tract was originally a lake bed, and when irrigated it became the most productive land in the Virgin River Valley. The map of this tract (fig. 3) shows that the canal passes on three sides of it. The water applied to the land flows from this canal toward the center of the tract, resulting in a concentration of waste water in the lower levels to such an extent that the soil is filled with water and the surface is so highly charged with alkali that much of it is useless. A drainage ditch has been opened and lateral ditches receiving waste water from irrigation discharge into this, but all attempts thus far made to drain this tract have proved unsuccessful. Ditches 3 and 4 feet deep failed to drain the land quite near to them. Water flows from the ditches, yet the soil contiguous to them is wet and alkali is found on the surface where there is no water. A rim of productive land borders the tract, but much of the interior is abandoned. The soil is a heterogeneous mass, without horizontal stratification, and for this reason surplus water goes downward rather than horizontally until it strikes an impervious material, after which it flows toward the lower levels and fills up the subsoil in those places. This accounts in part for the presence of water near drainage ditches. This condition is especially noticeable where land has considerable slope, as has this tract. The plan of drainage outlined on the map is merely an improvement on work already begun. It provides for enlarging the main drainage ditches, which were already properly located, and

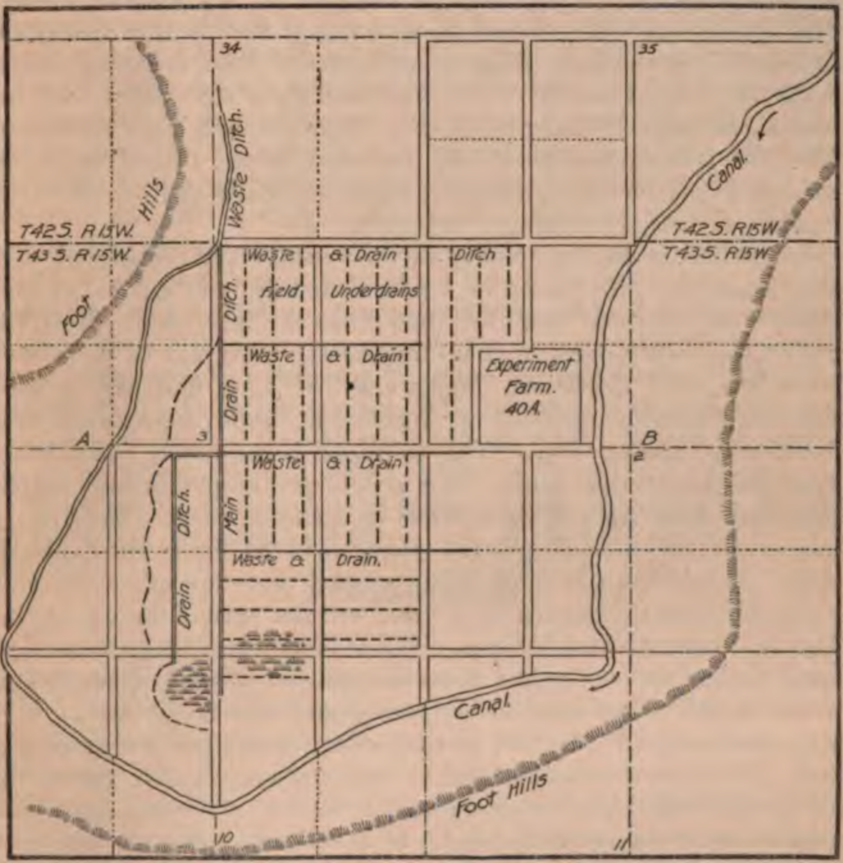

FIG. 3.—Map of irrigated tract in Virgin River Valley.

for placing the excavated earth back from the ditch banks to lessen the liability to caving. The field ditches are to be located across the greatest slope, as indicated on the map. Each of the field drains will intercept a portion of soil water coming from the higher lands and conduct it to the outlet ditches. Lumber is the best material for drains in this section and is practically the only available material. The land is so wet that it would be difficult to keep tile in line without lumber as a foundation, while box drains are in sections sufficiently long to keep in line even in very wet soil. These drains are boxes with one side open, made of boards 1¼ inches thick. Crosspieces on the open side hold the opposite sides in place. These boxes are placed in the ditch with the open side down and the sections are joined closely together. The water will enter the drains from the bottom and flow along the earth floors. Field drains 80 rods long may be made with sides of 6-inch board and top of 8-inch board, the crosspieces being 4 feet apart.

Conditions in Emery County in the vicinity of Huntington were also examined. No lands in Utah visited by the agents of this Office were in worse condition than those in the vicinity of Huntington, and other parts of this same county were said to be in very much the same condition. Many acres of land formerly productive were entirely destitute of vegetation, while other lands produced only inferior crops. This condition is constantly encroaching upon the productive fields. The people are desperate and realize that they must reclaim their lands or abandon them. Here, as in the vicinity of St. George, box drains will be found most practicable. Lumber can be more easily secured than any other material, while the mushy condition of the soil will not permit the use of tile. The recommendations for this section include the construction of open ditches for outlets and main laterals and the use of box drains in the fields. More care in irrigating and better cultivation were also recommended. In this section alkali conditions are extremely bad. The drains recommended would prevent further spread of alkali, but were not considered as a method of removing alkali already accumulated in the soil. It is believed, however, that providing ample drains will lead to the washing out of a large part of the alkali and restore the lands to productivity.

In Cache Valley large areas of lands have also become swamped, but here there is no trouble from alkali. The land rises from the streams in a series of benches, the lower lands being underlaid with clay and the higher lands with gravel. Only the higher benches have escaped injury from excessive use of water. The water from these higher levels comes to the surface on the successive benches below. It is found, however, that this water does not seep through the soil, but flows through holes varying from the size of a straw to

4 or 5 inches in diameter. The water flowing in such channels finds a break in the covering and comes to the surface, producing wet spots. Some of these spots very close to drains are not relieved by these drains, showing that there is little seepage through the soil. The causes of this peculiar condition have not been determined, but it is considered probable that the clay subsoil is not uniform, but contains basins where the water flowing through these holes accumulates. If this be true, each wet spot will require a treatment peculiar to itself. It is estimated that in some places this water moving through the soil flows at the rate of 1 mile in thirty-six hours. A large number of wells have been put down in this section to obtain a more accurate knowledge of subsoil conditions, and a record of changes in the ground-water level is being kept. Cooperative arrangements have been made with several farmers, under which this Department and the Utah Experiment Station furnish the tile and the farmers do the work. The farmers agree to do this work as directed by the agents of this Office and to plant crops and irrigate and cultivate the land as directed. These experiments have not been continued long enough to obtain conclusive results, but the condition of the farms where the experiments are being conducted is rapidly improving, and it is believed that the system adopted will prove satisfactory. These experiments, if successful, will demonstrate to landowners in this vicinity the methods which should be used to improve the condition of their lands.

Work similar to that done in Utah is being carried on in Nevada, Washington, Montana, and other parts of the arid region.

### HUMID SECTIONS.

The drainage work of this Office in the humid sections has been principally along the larger streams which are subject to floods which overflow the bottom lands. The conditions in districts needing drainage along the Missouri River in South Dakota, Iowa, and Nebraska have been examined and advice given regarding their drainage. Similar work has been done along the Mississippi and Illinois rivers in Illinois and along the Wabash River in Indiana. The reclamation of these bottom lands in most cases requires the construction of levees, as well as the excavation of drains and some provision for removing water from the lands inclosed in the levees. During 1904 an agent of this Office made a study of a large number of these leveed districts along the Illinois River. A description of the conditions found there will serve to illustrate the work in the reclamation of such lands.

During May and June of 1904 an investigation was made of the drainage conditions of the Illinois River bottom lands extending from Peoria to the mouth of the river. These bottom lands vary from 1 to 3 miles in width. The river has been improved for navigation purposes by means of locks and dams. There are three of these structures on this section, the object being to maintain a navigable channel throughout the low-water period. During the period covered by gauge readings, the maximum yearly floods have occurred from March to July, that of 1904 occurring the latter part of March, while the next highest recorded on the Havana gauge occurred late in July of 1902.

The river bank is approximately 12 feet above low water. Back from this the surface falls from 1 to 4 feet, and in places there are old channels and sloughs which are much lower. These bottom lands, except occasional sand ridges, have a gray alluvial soil, becoming black when mixed with vegetable matter, are covered with a heavy timber growth, and furnish some pasturage in the late summer and fall months. When cultivated, the higher parts of the bottoms yield crops about two years out of three, but the lower parts are flooded so frequently that it is not profitable to cultivate them. All of these bottom lands, when sufficiently drained and properly cultivated, produce large crops of corn and wheat. On account of the slight fall in the river, the level surface of the bottoms and their slight elevation above low water, the reclamation of these lands is expensive and often difficult.

Near Pekin, Havana, and Beardstown, organizations have been formed under the provisions of the State levee and drainage laws and attempts made to reclaim tracts of this land by means of levees and pumps. The Pekin-La Marsh levee and drainage district lies across the river from Pekin, covering an area of 2,500 acres, and is protected on all sides by levees, except about 1½ miles on the northwest, where the bluff forms the back line of the district.

An organization was effected in 1889 and work was completed in 1890. The Peoria and Pekin Union Railway grade was used for 1½ miles as a levee on the northwest side from the river to the bluff and 5 miles of new levee was constructed along the river bank and up La Marsh Creek to the bluff. This levee was constructed with scrapers. It has a 1½ to 1 slope on the river side and 1 to 1 slope on the inside, with a 3-foot top. The foundation for the embankment was not prepared in any way, stumps and logs being left, and in some instances trees were not even cut, and earth for construction was taken from both sides in such a manner as to leave a large continuous ditch on the inside. The company owning the section of railway track used as a levee filled in a trestle and raised its track, burying old timbers and ties in both cases. The drainage ditches were constructed with scrapers. The pumping plant was located at the upstream corner of the district and a 4-foot outlet for low-water drainage was made at the downstream corner of the district. The only hill water flowing into the district is that which falls on the slope of the bluff which forms the back line of the district. The present pumping plant consists of a Menge pump with two wheels, which operates against a maximum head of 15 feet.

The district was flooded in 1892 from a break in the railway grade, caused by the water seeping along the old ties until it carried the levee away. During March, 1904, the water ran over the lower part of the river levee and also over the railway grade, causing a break at each of these places. After the district was flooded great damage was done to the levee by wave action on the inside. It is now acknowledged by those interested in the district that the original cross section of the levee was too small, that it was poor practice to build the levee without first preparing the foundation to prevent seepage, to use banks with old timber running across them, and to have borrow pits on the inside. The drainage system would have been more efficient if the ditches had been made with a dredge and the pumping plant located at the downstream corner of the district.

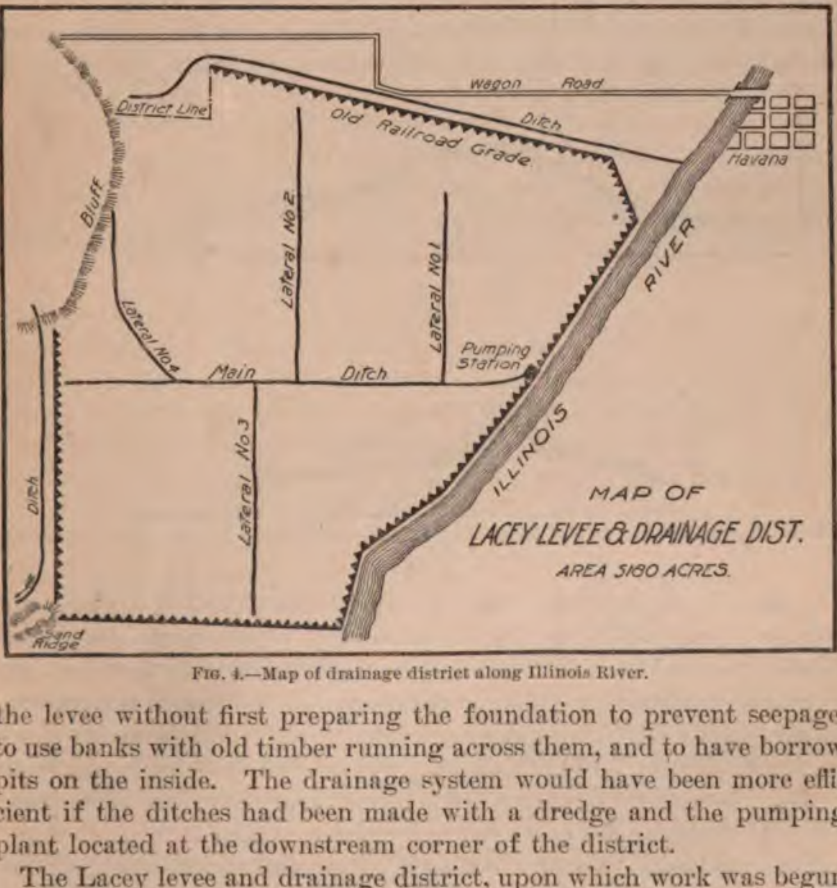

FIG. 4.—Map of drainage district along Illinois River.

The Lacey levee and drainage district, upon which work was begun in 1897, lies across the river from Havana. It covers an area of 5,180 acres and is protected by 9.5 miles of levee, 7 miles being new levee and 2.5 miles on the north side an old, unused railway grade. The bluff forms the back line of the district for a distance of 1 mile. (Fig. 4.) The river part of the levee was built on the ridge which marks the river bank in ordinary high water. It has a 2 to 1 slope on the outside and a 1 to 1 slope on the inside, with an 8-foot top. It varies in height from 6 to 13 feet, with an average of 8.1 feet. The foundation was prepared by clearing, grubbing, and thoroughly plowing the entire width of the base of the embankment, one short section having a 4-foot muck ditch under it. The work was done with scrapers, the earth all being taken from the outside, a 10-foot berm being left between the borrow pit and the toe of the slope. The district is drained by a system of dredge ditches, which are 6 feet deep but have no fall. The pumping plant is located near the middle of the river levee and consists of two high-speed engines, two horizontal fire-tube boilers, and two horizontal centrifugal pumps with 20-inch discharge pipes.

This district has not been successfully reclaimed because the levee was not built high enough. The top was supposed to be 20 feet above low water. In 1902 the river rose to 19.2 feet, and the water ran over the old railway grade, which served as the north levee and flooded the district. In March, 1904, the river rose to 19.9 feet, the water ran over the low places in the levee, and a break in the railway grade was caused by a wave which came from a break in an old levee on Spoon River. After the district was flooded there were very high winds, which greatly injured the levee by wave action on both inside and outside where not protected by timber. (Fig. 5.)

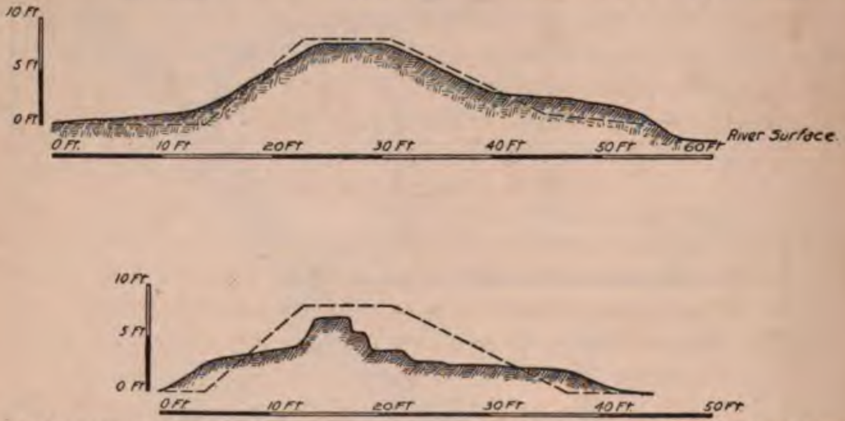

FIG. 5.—Diagram showing form of levees along Illinois River when constructed and as they now exist.

The Coal Creek levee and drainage district lies across the river from Beardstown, including an area of 7,000 acres, and was organized in 1896. The Chicago, Burlington and Quincy Railway grade is used as a levee from the river to the bluff on the east side. Six miles of new levee was built on the south and west side, it not being necessary to levee against the river water on the north side. With the exception of a short section at the north end of the west levee, it was constructed with a dipper dredge. The levee was raised to 3 feet above the 1844 high-water mark. It has a 3 to 1 slope on the outside and a 2 to 1 slope on the inside, but with no specified width of top. The foundation and the land used for the borrow pit were cleared, the stumps dynamited and pulled, and roots taken out to a depth of 3 feet. The earth was all taken from the outside, a 20-foot berm being left between the edge of the borrow pit and the toe of the slope.

The district has not been flooded by river water since the completion of the levee, and in that respect it is a success. The great difficulty experienced in the reclamation comes from the hill water. The streams which flow out of the bluff flow over the waste bank and flood the land within the district in such quantities that the pumping plant can not handle the water. For this reason the interior drainage system has never been completed. During high water there is a great deal of seepage through the railway grade and some through the district levee. It is thought that if there had been a muck ditch under the levee there would have been no seepage, as the water does not go through the embankment, but through the top 3 feet of the original earth, which contains a great deal of vegetable matter.

## LEVEE CONSTRUCTION.

The material of the low land bordering on the Illinois River is excellent for levee construction, as its texture prevents water percolating through it. A levee of this material when overtopped by a flood yields very slowly to the action of the water and only a small crevasse is formed. Only one crevasse was observed which was deeper than the original ground surface, and a number of places were observed where the water had run over the top for several days without producing any eroding effect. Wave action is the cause of the greatest injury to levees made of this material. Where the levee is exposed to an expanse of open water during a high wind the waves undercut the embankment at the surface of the water and the overhanging material falls into the water and is rapidly broken up and carried away, while the material above retains a vertical position. Where a levee is made of a sandy material the sand will not be dissolved, but will be rolled back by the action of the water, so that the overhanging mass will not assume a vertical form, but will be continually sliding down to the water's edge. Consequently wave action is to some extent retarded by the material from above the water line, and the slope is gradually flattened.

A levee foundation should be cleared of all vegetable matter and thoroughly plowed, and a muck ditch should be dug and refilled with good material. It should be from 2 to 4 feet in width and of sufficient depth to cut through all vegetable matter or sand strata which are found near the surface.

The proper cross section for a levee depends upon the material of which it is constructed and the length of time it will be subjected to the flood. The conclusion deduced from all observations so far made is that the standard slope for the river side of a levee should be 3 to 1 in all classes of material. This slope is flat enough to be easily constructed, is readily kept clear of weeds and bushes by the use of the mowing machine, does not slide when tramped over by stock in wet weather, is not difficult to set in grass, and offers greater resistance to the action of the waves than steeper slopes. The inside slope should vary from 2 to 1 in the best material, to 5 to 1 in the light sandy material. The better construction would be to make the inner slope 3 to 1 in the best material, and in the lighter material, where the levee is over 8 feet in height, to reenforce the inner slope with a banquette, the top of which should be kept at 8 feet below the top of the levee. The width and slope of the banquette will depend upon the material used and the height of the levee, but under ordinary conditions the top width of the banquette should be from 20 to 30 feet. Six feet is a sufficient width on top for levees of the above cross section.

To prevent the levee from being overtopped by waves, the crown should not be less than 3 feet above the highest known stage of water. The crown should be brought to an apex by topping the above-described cross section with 1 foot of earth. This lessens the risk of injury by such animals as moles and muskrats, which burrow near the surface through the levee, and also furnishes a supply of earth for repairs in case of an emergency.

In constructing a levee the earth should all be taken from the outside, a berm of not less than 10 feet being left between the foot of the embankment and the borrow pit, and the slope of the first 10 feet of the borrow pit should be not steeper than that of the levee. There are materials in some localities where it would be necessary to leave a wider berm or continue the levee slope to a much greater distance beyond the foot of the levee. Ditches and borrow pits on the inside of the levee are extremely objectionable, and in case it is necessary to borrow from the inside, earth should be obtained from a long distance, and in all cases deep pits should be avoided.

Weeds and bushes should not be permitted to grow on levees. The weeds die and blow over, loosening the surface; bushes and small trees kill the grass by shading the ground and their roots loosen the surface. The injurious effect of wave action is greatly increased by the presence of bushes and weeds, as their roots break the surface and cause erosion to begin. Large trees should not be permitted to grow near, as their roots will penetrate the base of the levee, giving an opportunity for seepage, and when the tree is cut or dies it will decay, leaving large openings, which may cause crevasses. To prevent wave action the slopes should be set in redtop, bluegrass, or Bermuda grass. A strip of small, thick timber should be kept between the levee and any open water from which waves can strike the levee. During a storm a levee can be protected from wave action by placing at the surface of the water sacks filled with sand, brush, cornstalks, lumber and straw, held in position by stakes and wire.

The grade line of the crown should be carefully inspected for at least two years after construction, especially where old channels and sloughs have been crossed, as settlement is liable to lower the top below the elevation which is necessary to insure protection during extreme floods.

Roads on the top of levees in a general way are objectionable, as low places are formed by ruts and chuck holes, and the edges of the crown are cut off by the wheels. If a levee is constructed with an additional top width for road purposes, and low places are promptly filled, the road would not be an injury to it. A better location for a road is on top of a banquette, which may be constructed on the inner slope. Fences should not be built on the slopes paralleling the levee, and they are objectionable on the crown. Where it is practicable to keep the slopes free from weeds and long grass by mowing, that method should be used. Where mowing is impracticable, the levee should be pastured, stock being kept off when the frost is coming out of the ground and during dry, hot weather, when there is danger of injuring the sod by close grazing. The flatter the slopes the less injury will be done to the surface by tramping. Some trails will be made on the levee and some injury done to steep slopes, but usually the sod becomes tougher and the surface firmer where pastured. The pastured levee will also be in better condition to resist the eroding force of the water than the one which is abandoned to weeds and brush. During flood periods a patrol is necessary to seek out and strengthen weak places. Many crevasses originate from very small beginnings, and can be prevented if taken in time.

The lands along the Illinois River range in price from $5 to $60 per acre, the lower value being for the land which floods every year and will furnish no valuable timber. The higher price is that at which owners hold high land, which overflows only at times of extreme high water.

During the low-water years of the nineties large yields of corn and wheat were grown on such lands as were then reclaimed and its price advanced to $60 per acre. Had they been successfully protected from the water during the floods of 1902 and 1904 the value of these lands would have been greatly increased, as uplands, which are not as productive, are now valued at $125 to $150 per acre. The following estimate of the cost of reclaiming these lands is based on conditions in the Lacey district.

*Estimated cost of reclamation per acre.*

| | |
|---|---|
| Original cost | $5.00 |
| Cost of clearing | 15.00 |
| Buildings and improvements | 10.00 |
| Levee assessment | 14.00 |
| Additional levee assessment which would have been necessary to have constructed the levee to a sufficient height and cross section to withstand the flood waters | 10.00 |
| Total cost | 54.00 |

*Annual expense.*

| | |
|---|---|
| Interest on first cost, at 6 per cent | $3.24 |
| Taxes, insurance, and repairs | 1.00 |
| Pumping tax | 1.00 |
| Total | 5.24 |
| Average annual rental | 7.50 |
| Annual net profits | 2.26 |

The productive possibilities of these lands are now being appreciated, and renewed interest and activity is being taken in the work of their reclamation. The problems to be dealt with and the nature of the work necessary to be done is being better understood by the landowner, so that more profitable results will doubtless be obtained in the future than have been realized in the past.

## MACHINERY FOR LAYING TILE DRAINS.

Experiments with machinery for digging trenches for tile drains were carried on in cooperation with the Iowa State Agricultural College under the direction of Prof. C. J. Zintheo. The machines experimented with consisted of a cutting wheel and a boiler and engine used both for traction and operating the cutting wheel. Two views of this machine are shown in Plate XXIII. The experiment was made on a farm of 480 acres, 320 acres of which needed drainage. It was found necessary to make an open ditch 3 feet 8 inches deep to care for the water coming from the higher lands. This was done with teams and scrapers at a contract price of $9 per 100 running feet, or 9 cents per foot. This ditch was 3,650 feet long, making a total cost of $328.50. This work cost the contractor $282.50, or 7.7 cents per running foot, leaving him a profit of $46.

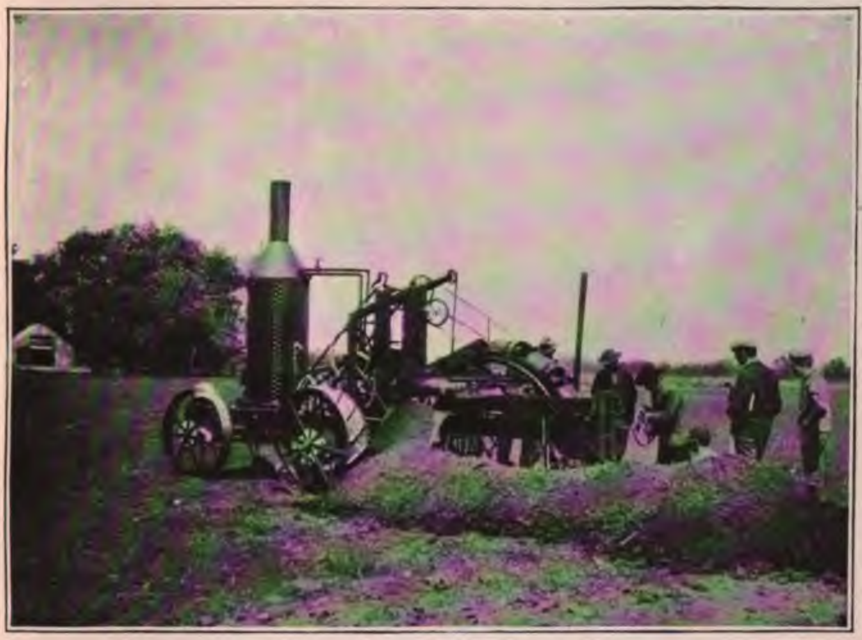

FIG. 1.—MACHINE DIGGING DITCHES FOR TILE DRAINS, SIDE VIEW.

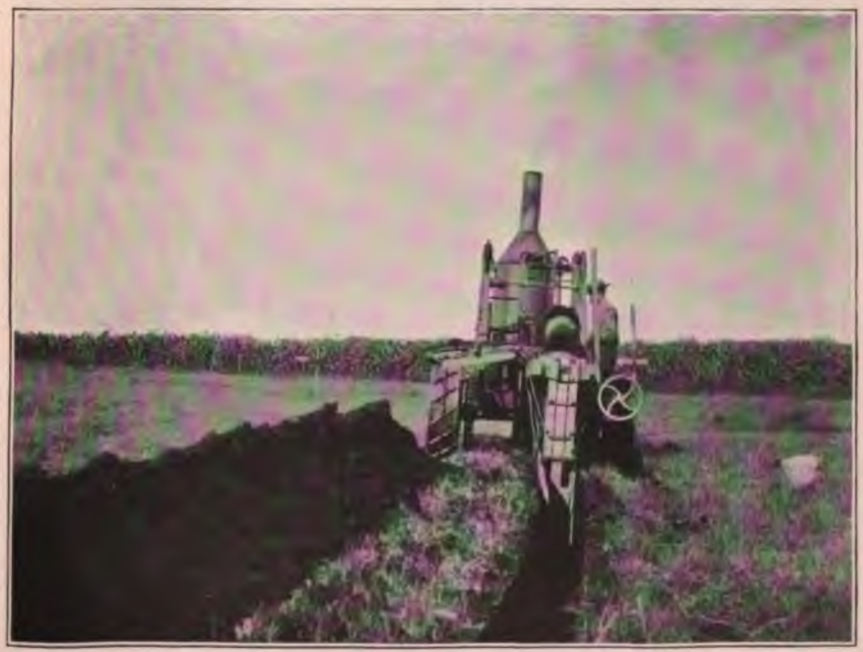

FIG. 2.—MACHINE DIGGING DITCHES FOR TILE DRAINS, REAR VIEW.

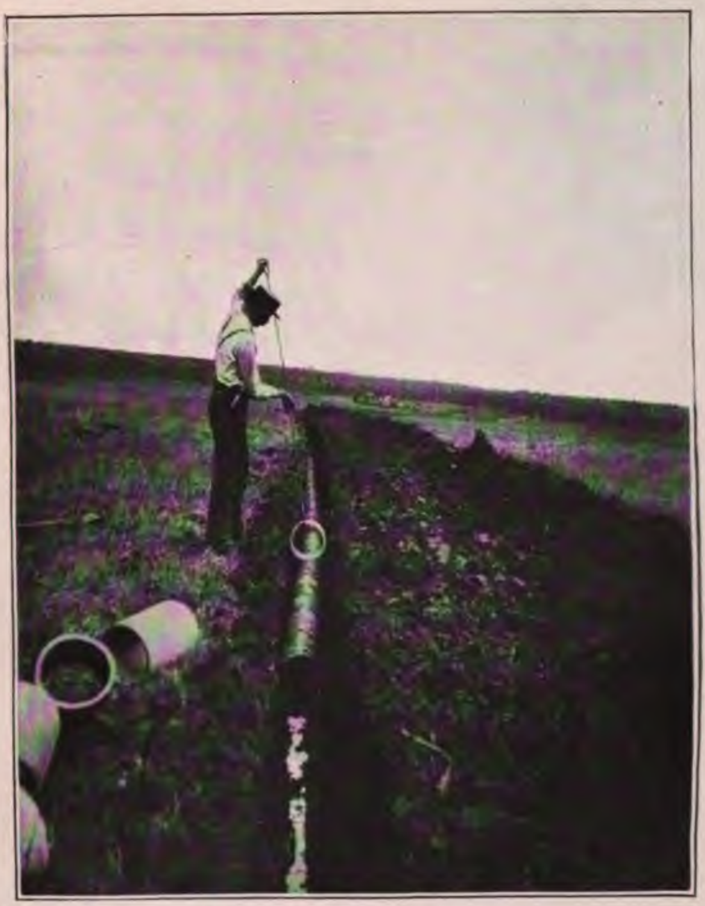

FIG. 1.—LAYING TILE IN TRENCH.

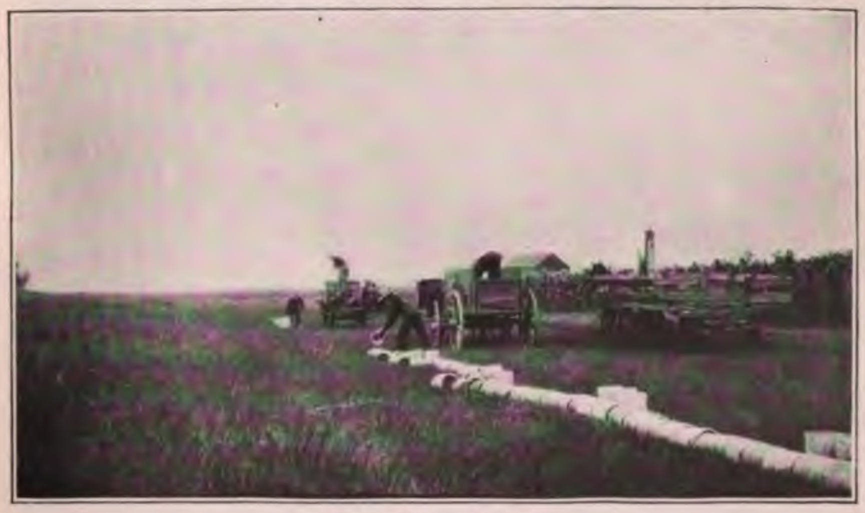

FIG. 2.—DISTRIBUTING TILE.

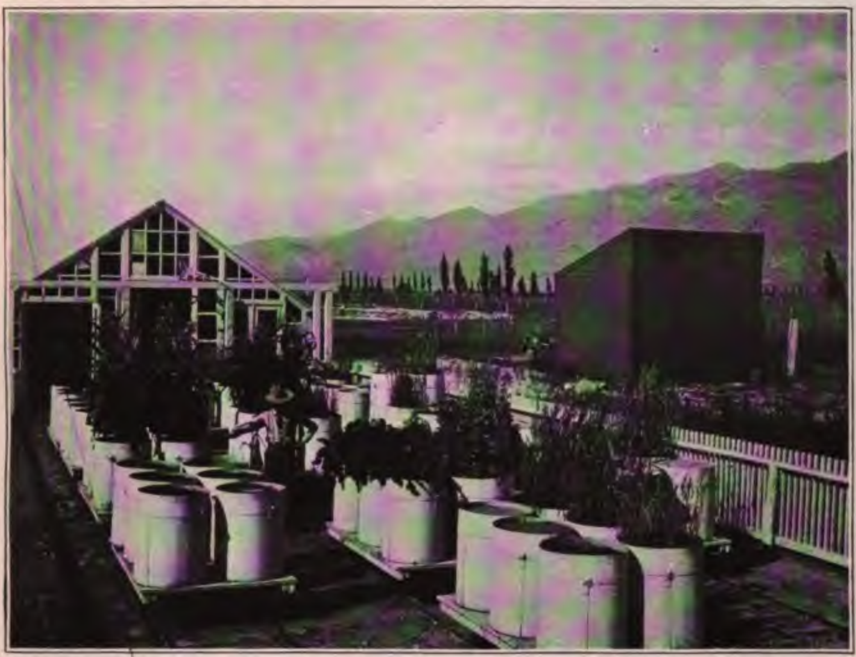

FIG. 1.—TANKS USED IN TESTING THE EFFECT OF DIFFERENT QUANTITIES OF WATER USED IN IRRIGATION ON THE GROWTH OF CROPS.

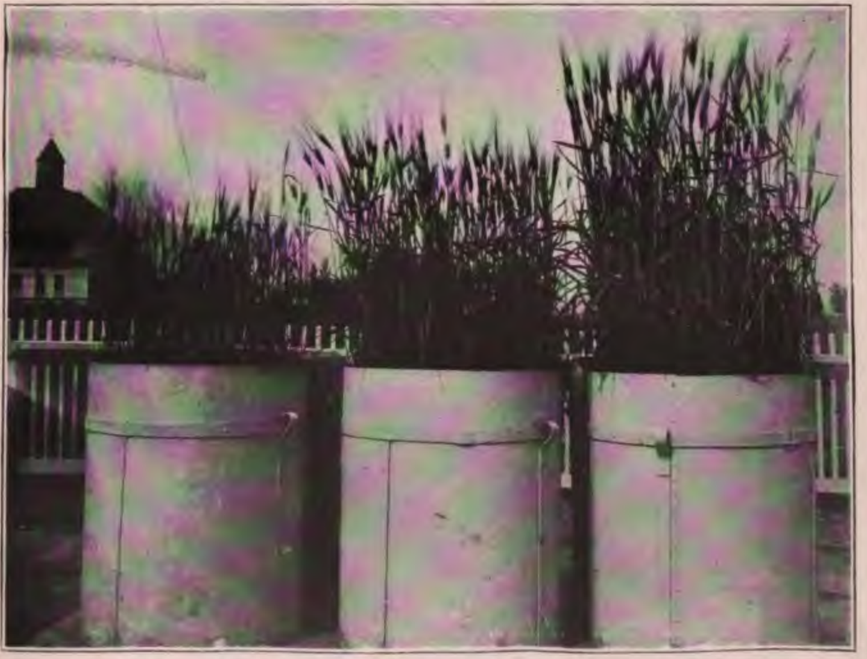

FIG. 2.—EFFECT ON THE GROWTH OF BARLEY OF APPLYING DIFFERENT QUANTITIES OF WATER.

The machine experimented with was used to dig the other ditches for this farm. It requires two men to run the ditcher, one to fire and keep up steam, and the other to run the excavating wheel and see that it cuts the ditch true to grade. When the work is going properly a third man is required to lay the tile and cover them sufficiently to hold them in place. (Pl. XXIV.) The following table gives the cost per day for running this machine, including attendance and fuel:

*Cost of operating ditching machine per day.*

| | |
|---|---|
| 2 men, at $1.75 per day, with board, at $3 per week | $4. 36 |
| Superintending leveling, putting in grade stakes, inspecting work, etc | 2. 00 |
| Laying and covering tile | 2. 54 |
| 1,310 pounds of coal, at $3.50 per ton delivered | 2. 30 |
| Water for boiler | 1. 08 |
| Oil | . 15 |
| Total cost per day | 12. 43 |

The following table gives various items as to the work done and its cost:

*Data regarding work done.*

| | | |
|---|---|---|
| 8-inch tile laid | feet | 3, 450 |
| 6-inch tile laid | do | 1, 000 |
| 4-inch tile laid | do | 4, 270 |
| Total tile laid | do | 8, 720 |
| Total length of ditch dug by machine | do | 8, 520 |
| Total length of ditch dug by hand | do | 200 |
| Average depth of digging | do | $3\frac{7}{12}$ |
| Average distance dug per day | do | 725 |
| Best day's digging | do | 1, 000 |
| Average cost per rod digging ditch and laying tile | cents | 28. 25 |
| Total cost of digging 8,720 feet, or 529 rods | | $149. 44 |

The estimated cost of doing this same work by hand is shown in the following table:

*Estimated cost of digging ditches by hand.*

| | |
|---|---|
| 210 rods for 8-inch tile, at 45 cents | $94. 50 |
| 60 rods for 6-inch tile, at 40 cents | 24. 00 |
| 259 rods for 4-inch tile, at 30 cents | 77. 70 |
| Total cost for hand digging | 196. 20 |
| Difference in favor of machine digging | 46. 76 |
| Difference in favor of machine digging, per rod | . 09 |

Besides the lower cost there is the advantage of a saving in time or in the number of men employed. This work required three men and a machine for 11.75 days. It would take three men 29.4 days to do the same work by hand. Where help is scarce, as it is in Iowa, a saving of time is quite an advantage. The operation of the machine required skill even under the best conditions, and on very wet lands the machine will not work at all. This machine is not, therefore, recommended for the farmer unless he has a great deal of ditching to do, but contractors for this class of work would probably find it a good investment, as they could employ men who are trained in the operation of the machine and keep the machine and men employed a good part of the time.

## COOPERATIVE WORK.

The work outlined in the preceding pages has been carried on in part under the direction of members of the regular force and in part by scientists connected with a number of colleges and experiment stations. The following is an outline of the organization under which the work was carried on in 1904:

Prof. S. Fortier, with headquarters at the University of California at Berkeley, has had charge of all work in that State. The university and the State experiment station have aided in the work of this Office in the following manner: By giving a headquarters office free of rent; by aiding in the testing of pumps in the mechanical laboratory; by making free of cost a large number of water analyses; by aiding in a study of the effects of irrigation on the quality of fruits and vegetables. Professor Fortier was assisted by Prof. J. N. Le Conte and Prof. E. J. Wickson, of the State University, and Mr. Frank Adams and Mr. A. J. Turner, of this Office.

In Nevada we have cooperated with the State experiment station under a special State appropriation, the work being under the direction of Prof. Gordon H. True, of the State station.

In Oregon the field work was carried on under the direction of Director James Withycombe, of the State station, with Prof. F. L. Kent, as assistant.

In Washington field work was carried on under the direction of Prof. O. L. Waller, of the State station, with Albert L. Smith, as assistant.

In Idaho, Mr. W. F. Bartlett, of this Office, was detailed for field work in cooperation with the State engineer's office.

In Utah field work was under the direction of Director J. A. Widtsoe, of the Utah Experiment Station, with Prof. W. W. McLaughlin, as assistant.

Plate XXV, figures 1 and 2, shows some of the work being done with crops grown in tanks to show the effect of the application of different quantities of water and the rate of loss by evaporation from soils and from the leaves of plants.

In Montana field work was carried on under the direction of

Director F. B. Linfield, of the State experiment station, with Prof. J. S. Baker, as assistant.

In Colorado field work was carried on in part by Mr. A. E. Wright, of this Office, and in part under the direction of Prof. L. G. Carpenter, director of the State experiment station, with Mr. S. L. Boothroyd and Mr. P. J. Preston as field assistants.

In Nebraska field work was under the direction of Prof. O. V. P. Stout, of the State University.

In Kansas field work was carried on at Garden City under the direction of Mr. A. E. Wright and Mr. A. B. Collins, of this Office, and at Hays under the direction of Mr. J. G. Haney, of the State experiment station.

In Louisiana field work was carried on by Prof. W. B. Gregory and Prof. Morton A. Aldrich, of Tulane University.

In New Mexico field work was under the direction of Prof. J. J. Vernon, of the State experiment station.

In Arkansas the work was in part under the direction of Director W. G. Vincenheller, of the State experiment station, and in part done by C. E. Tait, of this Office.

In Indiana field work in drainage was under the direction of Prof. W. D. Pence, of Purdue University, assisted by Mr. K. B. Duncan.

In Iowa field work in drainage and the testing of drainage and pumping machinery was under the direction of Prof. C. J. Zintheo.

In Wisconsin field work was under the direction of Prof. A. R. Whitson; in New Jersey, under the direction of Prof. E. B. Voorhees; in Porto Rico, under the direction of D. W. May, special agent in charge of the experiment station, and in Hawaii, under the direction of Jared G. Smith, special agent in charge of the experiment station.

Reports of cooperative investigations have not been received from Hawaii, Montana, Colorado, and Nebraska.

## IRRIGATION AND DRAINAGE PUBLICATIONS.

During the year ended June 30, 1904, there were issued 5 bulletins, 1 Farmers' Bulletin, 2 circulars, 1 Yearbook article, and an article for the annual report of the Office. There were also submitted for publication, but not actually printed, 5 bulletins and 1 special pamphlet for use at the St. Louis Exposition. Several separates have been reprinted, and a second edition of a large bulletin has been issued. The new matter published contains 717 pages and the second edition 330 pages.

The bulletins actually issued during the year were as follows:

Egyptian Irrigation, by Clarence T. Johnston, Assistant Chief of Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 130, pp. 100, pls. 24, figs. 9.)

This is a study of the irrigation laws and practices in Egypt, made with special reference to suggestions for improvements in American irrigation.

Plans of Structures in Use on Irrigation Canals in the United States, prepared under the direction of Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 131, pp. 51, pls. 22.)

This is an album of plans for irrigation structures, designed by leading irrigation engineers of the West, made from drawings exhibited at Paris in 1900 and at Buffalo in 1901.

Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations, containing the following reports: Irrigation in the Mountain Water District of Salt Lake County, Utah, by E. R. Morgan; The Use of Water from the Wood Rivers, Idaho, by J. D. Stannard; Irrigation Investigations on Sand Creek, Albany County, Wyo., by B. P. Fleming; Irrigation in Washington, by O. L. Waller; Irrigation Investigations in Montana, by Samuel Fortier; Irrigation Systems on Stony Creek, Cal., by W. T. Clarke and C. W. Landis; Irrigation in the Black Hills, S. Dak., by A. B. Crane; Rice Irrigation in Louisiana and Texas, by Frank Bond; Third Progress Report on Silt Measurements, by J. C. Nagle; Irrigation Experiments at the Missouri Experiment Station, by H. J. Waters; Irrigation in Wisconsin in 1902, by A. R. Whitson; Irrigation Investigations in New Jersey, 1902, by E. B. Voorhees; Use of Pumps for Irrigation in Hawaii, by Jared G. Smith. (Bulletin No. 133, pp. 265, pls. 12, figs. 16.)

This bulletin gives the results of the fourth season's investigations of the problems of irrigation, the results obtained in similar investigations in previous years being reported in Bulletins 86, 104, and 119 of this Office.

Storage of Water on Cache la Poudre and Big Thompson Rivers, by C. E. Tait, Assistant in Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 134, pp. 100, pls. 5, figs. 10.)

The reservoirs built for the storage of the winter and flood discharges of these two streams are described, and some of the results of the use of stored water are also given.

The Acquirement of Water Rights in the Arkansas Valley, Colorado, by J. S. Greene, ex-State engineer of Colorado. (Bulletin No. 140, pp. 83, pl. 1, fig. 1.)

This bulletin discusses the laws of the State governing the acquirement of rights in relation to the physical conditions of the valley; the organization of canal companies and the contracts and agreements under which they dispose of water, in relation to physical conditions, State laws, and the prosperity of farmers and canal builders, and the judicial and administrative customs and institutions of the State as they affect the agricultural industry of the valley and the State as a whole. This bulletin is intended primarily for the benefit of intending investors and settlers. It gives them a knowledge of the conditions which should be looked into before investments are made and points out the sources of the desired information. It is also a study of the laws and institutions of the State from the standpoint of their effect upon the prosperity of the State, by one who has had a large part in developing the system under consideration and is deeply interested in the future of the State.

Drainage of Farm Lands, by C. G. Elliott, Drainage Expert, Irrigation Investigations, Office of Experiment Stations. (Farmers' Bulletin No. 187, pp. 40, figs. 19.)

This bulletin gives practical directions for laying out drains, digging trenches, laying tiles, and caring for drains. It gives also directions to enable farmers to determine what kinds of drains to make, how large to make them, and the cost.

Supplemental Report on Drainage in the Fresno District, California, by C. G. Elliott, Agent and Expert, Irrigation Investigations, Office of Experiment Stations. (Circular No. 57, pp. 5.)

A report on drainage plans for the district around Fresno, Cal., was published last year. This circular gives additional data on the rise and fall of the ground-water level during the year, to be used as a basis for computing the capacity of drains to be supplied.

Irrigation in the Valley of Lost River, Idaho, by Albert Eugene Wright, Agent and Expert, Irrigation Investigations, Office of Experiment Stations. (Circular No. 58, pp. 24.)

Lost River, Idaho, sinks in the sands of its bed and rises again below. Mr. Wright made a series of measurements to determine the losses of water from the river and the effects of diversions above the sinks on the flow of the river below. This report contains the result of his observations and measurements.

Review of Irrigation Investigations for 1903, by Elwood Mead, Chief of Irrigation Investigations, Office of Experiment Stations. Pp. iv, 469–502, pls. 6. (Reprint from Annual Report of Office of Experiment Stations for 1903.)

This is a report of the work of this Office for the year ended June 30, 1903, telling what work was carried on and the localities where it was done.

Preparing Land for Irrigation, by R. P. Teele. Pp. 12, pls. 2, figs. 5. (Reprint from Yearbook, 1903.)

This is a brief article on methods of clearing and leveling land, laying out ditches, and applying water, based on Bulletin No. 145, referred to hereafter.

The following publications were prepared and submitted for publication but not actually printed before the end of the fiscal year. They have since been issued:

Irrigation in Northern Italy, Part I, by Elwood Mead, Chief of Irrigation Investigations. (Bulletin No. 144, pp. 100, pls. 17, figs. 14.)

Doctor Mead spent the summer of 1903 in Italy studying the systems of administration of streams, construction of irrigation works, methods of operating canals, and agricultural practices. This bulletin is a partial report of his observations. It describes the irrigation works of Lombardy and Piedmont, the system of agriculture followed, the laws under which works are built and managed, and the laws and customs under which they are maintained and the water distributed to farmers. Cooperation in ditch management has gone much further in Italy than in the United States. The benefits derived from this are among the most important things brought out by this bulletin. Public control of the use of streams is also more complete in Italy than in the United States, the Government maintaining a board which determines the feasibility of proposed ditch projects and the likelihood of interference with existing rights.

**Preparing Land for Irrigation and Methods of Applying Water. (Bulletin No. 145, pp. 84, pls. 7, figs. 33.)**

Each year tens of thousands of farmers begin irrigation. Most of them come from sections where irrigation is not practiced, and they are therefore entirely unfamiliar with methods of irrigation farming. This bulletin is prepared especially for such farmers. It deals with methods of removing sagebrush, leveling land, applying water, and the preparation of the land for the different systems of putting on water. The conditions governing the choice of a method of irrigating are discussed, and comparative statements of cost are given. There are many things about irrigation farming which can be learned by experience only, but this bulletin will be of great help to beginners by giving them the results of the experience of others. It is fully illustrated from drawings and photographs of the implements and structures used and methods employed.

**Current Wheels: Their Use in Lifting Water for Irrigation. (Bulletin No. 146, pp. 38, pls. 4, figs. 21.)**

Current wheels are often the cheapest means of raising small volumes of water short distances where much larger volumes are flowing by. A wheel can lift only a small percentage of the water passing it, and the cost of construction increases so rapidly with increased size that the large wheels necessary for high lifts can not be profitably built, but there are many places along streams and the upper sections of canals where enough water for a small area can be lifted a few feet with almost no cash outlay and without injury to lower users except for the small quantity of water taken. Bulletin No. 146 gives illustrations of a number of wheels which are in use, with statements as to the material required, the cost of construction, and the area served.

With the drawings and data given in this bulletin any farmer having ordinary tools should be able to construct a current wheel.

**Report on Drainage Investigations in 1903, by C. G. Elliott, Drainage Expert, Irrigation Investigations, Office of Experiment Stations. (Bulletin No. 147, pp. 62, pls. 5, figs. 12.)**

It is estimated that east of the one hundredth meridian there are about 100,000,000 acres of land too wet for agricultural use which can be reclaimed by drainage. West of that line there are large areas which, while they are in an arid region, receive sufficient drainage water from higher lands or from ditches to render them unproductive. These lands can also be reclaimed by drainage. The work of this Office has been the making of plans for the drainage of wet lands in all parts of the United States and the giving of advice on drainage projects. Bulletin No. 147 describes the conditions found in a number of localities examined and gives the plans worked out for their reclamation. While the report deals with specific localities, it is valuable for other regions, since it will suggest the steps which should be taken there.

**Report on Irrigation Investigations in Humid Sections of the United States in 1903, under the direction of Elwood Mead. (Bulletin No. 148, pp. 45, pls. 3.)**

This report deals almost exclusively with the irrigation of market-garden crops. Most of these grow rapidly and have but a short season, and a few days of dry weather seriously check their growth. There are few seasons when such dry periods do not occur, and irrigation as an insurance against them has proved very profitable. This bulletin contains a number of reports describing the works used and the crops raised in different sections. Irrigation in Market Garden Districts in the Vicinity of Eastern Cities, by E. B. Voorhees, describes a number of plants in the vicinities of Boston and New York and gives the cost and something as to the profits realized. Irrigation Experiments in New Jersey in 1903, by E. B. Voorhees, gives the results of experiments with asparagus and small fruits at the New Jersey Experiment Station. Irrigation During the Season of 1903 at Missouri Agricultural Experiment Station, by H. J. Waters, gives the results of irrigation of strawberries, asparagus, nursery stock, onions, and corn. One of the most notable results was the prevention of rust on asparagus. Irrigation in the Artesian Basin of South Dakota, by A. B. Crane, describes the wells in James River Valley of South Dakota and discusses the results of the use of their water for irrigation.

**Irrigation and Drainage Investigations of the Office of Experiment Stations, by R. P. Teele. (Document No. 723, pp. 23, pls. 2, figs. 5.)**

This is a general statement of the lines of work being carried on by this Office, primarily for distribution at the Louisiana Purchase Exposition. It gives the objects of the various lines of work undertaken and a brief statement of the methods employed and the results obtained.

In accordance with a joint resolution of Congress, a second edition of 4,000 copies of Bulletin No. 124, on Irrigation in Utah, was issued. This is a detailed study of the laws of Utah and the institutions of that State for controlling streams, managing ditches, and using water. It contains also a general discussion of irrigation in Utah, based on the more detailed reports given.

# DIETETICS IN RELATION TO HOSPITALS FOR THE INSANE.

By W. O. Atwater, *Chief of Nutrition Investigations.*

## INTRODUCTION.

Wherever a large number of persons are fed at public or private expense, as in the Army and Navy, hospitals, prisons, almshouses, and large boarding houses, certain questions very naturally arise in connection with the food supplies so used. Among such questions are these:

(1) Are the amounts of nutrients allowed and consumed adequate to the individual need?

(2) Is the diet sufficiently varied, wholesome, and attractive?

(3) Is the most economical system or method followed for providing, preparing, serving, and utilizing the food?

Until within a very few years the value of dietary studies for answering such questions, and particularly the last two, has not been fully realized, for the reason that they have been largely undertaken from the purely physiological point of view, to ascertain the requirements of the human body. But the need for practical application of the knowledge gained by such inquiries has gradually developed, as there has come to be a better realization of the enormous sums expended for food not only in private families, but for the various classes of people living at the expense of the state.

The importance of more thorough study of the dietaries of public institutions and other large groups of persons fed under more or less uniform conditions either at public cost or by private means is coming to be generally felt. The number of charitable institutions and the number of persons supported in them at the expense of the community is already large, and rapidly increasing. The philanthropy of to-day demands that the welfare of the inmates shall be most carefully considered. The cost to the taxpayer requires the closest economy consistent with their welfare.

In the home, on the farm, in the factory, in commercial establishments, on railroads, in municipal enterprises—indeed, almost everywhere—the results of scientific research are being put to practical use. It would seem that they ought to be capable of being utilized in the dietetic management of public institutions. The probability of their successful application here is rendered all the greater by the fact that during the past few decades a very large amount of scientific inquiry, and that of the highest order, has been devoted to the studies of food and nutrition.

A few words regarding what has already been accomplished in the proper feeding of groups may not be out of place. The problem of properly feeding the Army and Navy has for many years received the attention it deserves, and, in general, it may be said that all civilized nations make the attempt to do this in accordance with well-established principles of nutrition. Numerous dietary studies have been made at schools, universities, and other educational institutions in various countries. In many instances it has been possible to make suggestions for improving the diet materially without increasing its cost, or for decreasing the cost without affecting the nutritive value or attractiveness.

Ever since the care of the insane has received its due share of attention as a branch of medicine, attempts have been made, as a matter of course, to suit the diet to the need of the patients, and American and European literature contains many references to diet tables, lists of food served, and similar data. As early as 1843, J. Pereira,[a] in his treatise on food and diet, gives data regarding the kind and amount of food consumed at three English hospitals for the insane, and C. A. Lee,[b] in his supplement to the American edition of Pereira's book, gives similar data for the Boston Lunatic Hospital and the Lunatic Asylum at Manhattanville, N. Y. In his report on food and diet suited for almshouses, prisons, and hospitals, J. S. Gould[c] also gives data regarding the food served at the Boston Lunatic Asylum. The reports of hospitals for the insane and similar public institutions undoubtedly contain much data of a similar nature, but as yet no attempt has been made to collect such information.

In 1893, Dr. Austin Flint[d] prepared a dietary schedule for New York State hospitals for the insane at the request of the State commissioners in lunacy, who recognized the need of some uniform and rational system of dietetics for such institutions. The following year the recommendations for diet and food supplies at State hospitals were somewhat modified on the basis of experience.[e]

There are apparently few reports of actual dietary studies in American institutions for the insane. J. D. Munson[f] gives a brief acount of such investigations at the Kankakee and Northern Michigan asylums, the study at the Kankakee institution having been made by Miss S. E. Wentworth. Similar in scope is the work of Mrs. Ellen H. Richards and Miss S. E. Wentworth[a] at nine institutions in Boston for charity and correction. The conditions at some of these institutions may perhaps be fairly compared with those existing at hospitals for the insane, though none of them were especially designed for this class.

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[a] A treatise on food and diet. New York, 1843, p. 255.

[b] Ibid., p. 317.

[c] A report on food and diet suited for almshouses, prisons, and hospitals. New York, 1852.

[d] New York State Com. Lunacy Rpt., 5 (1892-93), p. 13.

[e] New York State Com. Lunacy Rpt., 6 (1893-94), p. 14.

[f] Amer. Jour. Insanity, 52 (1895-96), p. 58.

General discussions of hospital dietetics have been published by Mrs. Richards,[b] C. W. Pilgrim,[c] and undoubtedly by many others.

A number of reports of investigations regarding the diet of the insane and related topics have been published by European investigators, but no attempt is made to summarize this work here.

A few years ago the writer began a study of the methods and practice of feeding the inmates of hospitals for the insane at the Connecticut State Hospital,[d] and later continued the work, in a more extended and systematic way, in the New York State hospitals.[e] The results of these investigations proved of such value that a series of similar studies was inaugurated at the Government Hospital for the Insane, Washington, D. C. With the cordial cooperation of the superintendents of this hospital it was possible to make a large number of valuable studies there at small expense and without interfering with the regular routine. The results of these studies are reported and discussed in a bulletin[f] recently published by the Office of Experiment Stations. A résumé of some points connected with the work follows:

## FOOD STUDIES AT THE GOVERNMENT HOSPITAL FOR THE INSANE.

In an institution like a hospital for the insane, where there are so many different classes of patients, and especially in one where there are many different dining rooms and kitchens, to complete such an investigation as this would ordinarily require considerable time. Fortunately for the progress of the investigation at the Government hospital it was possible to make very satisfactory arrangements for the prosecution of the inquiry, and these were readily agreed to by Dr. A. B. Richardson, who until his death was superintendent of the institution and who thoroughly appreciated the requirements of the work. His successor, Dr. W. A. White, also recognized the value of the work and aided it so far as was practicable. Mr. H. A. Pratt, who for several years has been associated with the nutrition investigations of the Department of Agriculture, which center at Middletown, Conn., and had assisted in carrying on the inquiry in the hospitals for the insane in New York, was given charge of the details of the studies. With this cooperation the results accomplished at the hospital during the experimental period were large and furnished a number of interesting and suggestive facts. At the same time the investigation did not interfere in the least with the regular routine of the work there.

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[a] Institutions Commr. Rpt., 2 (1897), p. 206.

[b] Amer. Jour. Insanity, 52 (1895–96), p. 214.

[c] Ibid., p. 229.

[d] Connecticut Storrs Sta. Rpt. 1899, p. 142.

[e] New York State Com. Lunacy Rpts., 10 (1897–98), I, p. 31; 11 (1898–99), p. 190; 12 (1899–1900), p. 68; 13 (1900–1901), p. 39.

[f] U. S. Dept. Agr., Office of Experiment Stations Bul. 150.

The more important part of the inquiry carried on consisted of dietary studies in different wards and dining rooms. Each study included determinations of the amounts of different cooked foods sent to the dining room, food served at the table, food rejected, and food which was not served and was returned to the kitchen. Record was also kept of the number of persons at each meal during the study. These data served for the calculation of the quantities of nutrients and energy per man in the food served, eaten, and rejected. Observations were also made of the methods of preparing, cooking, and serving the food and of utilizing that which had been sent into the dining room but had not been served.

## FOOD CONSUMPTION.

Twenty-six such studies, each one week in duration, were completed and reported; 22 with patients and 4 with employees. The total number of persons included approximately 1,600 male patients and 125 employees, both male and female. The results showed that on an average the food consumed—i. e., food actually eaten by the patients (males)—furnished 90 grams of protein, 102 grams of fat, 359 grams of carbohydrates, and 2,705 calories of energy per man per day. In a few of the wards the food consumption was somewhat lower than this and in some it was higher, but in the majority of cases the variation of the individual studies from the average was not unusually wide. The results of the four studies with employees showed that they ate on an average 123 grams of protein, 169 grams of fat, 493 grams of carbohydrates, and 3,970 calories of energy per man per day. Considering patients and employees together, the average for the total number included in these studies was 92 grams of protein, 106 grams of fat, 368 grams of carbohydrates, and 2,785 calories of energy per man per day.

Whether these figures would represent the diet for the whole institution it is impossible to state with certainty, because there were several wards in which studies were not made; but from a superficial observation of the patients and employees in these wards it was believed that in respect to their physiological needs or actual food consumption they did not differ materially from those included in the studies. Since the number of persons included in the studies was rather more than half of the total population of the hospital and represented most or all of the different classes of patients and employees, it is probable that the average of the results obtained gives a fair indication of the conditions for the whole institution.

A comparison of these results with those obtained in other institutions and with commonly accepted dietary standards indicates that the patients and employees at the Government hospital were certainly receiving adequate nourishment. In an extended series of investigations carried on in the New York State hospitals for the insane, under the writer's direction, it was found that the food consumption of male patients in 26 studies averaged 89 grams of protein and 2,685 calories of energy per man per day, and that of employees, male and female, in 6 studies averaged 95 grams of protein and 3,185 calories of energy per man per day, the average of all 32 studies being 90 grams of protein and 2,700 calories. Both patients and employees apparently had fully as much food as they cared to eat. The food itself was of excellent quality and generally well cooked and served. There was a liberal allowance of meats. The diet was more or less varied. There were no apparent indications of undernourishment—indeed, the population of the hospitals appeared to be well fed. It is noticeable that the food consumption at the Government hospital was about the same for the patients but appreciably larger for the employees than for corresponding groups at the New York hospitals.

It would hardly seem that the requirements of the patients as a whole in this institution are larger than those of men in ordinary life at sedentary occupation, since the majority of them had no active employment. A commonly accepted dietary standard for such persons which is known to be liberal as regards protein, calls for 100 grams of protein and 2,700 calories of energy. As shown by the figusre given above, the average food consumption of the patients was near enough to this to warrant the assumption that it was sufficient to meet their bodily needs.

The employees included in the studies comprised officers, clerks, ward and dining-room attendants, waiters, and house girls. In respect to food requirements these may perhaps be compared with men at light to moderate muscular work, in which case the commonly accepted dietary standard calls for 112 grams of protein and 3,040 calories of energy. Considering the four studies with attendants, the average for which is given above, their diet would seem to be very generous if not excessive.

## FOOD WASTE.

From the statistics of food purchased for the hospital during the year ending just before these studies were begun it was calculated that the supply was sufficient to furnish the total population for the year an average of 127 grams of protein, 172 grams of fat, 517 grams of carbohydrates, and 4,107 calories of energy per man per day. Similar figures were not obtained for the food purchased during the time of the studies, but from an examination of the accounts it seems fair to assume that the supply would differ but little from that of the preceding year in actual nutritive value. Assuming that there would be no difference in this respect, and that the average food consumption found in the dietary studies represents the condition for the total population, it would appear that between the purchase of the supplies and the serving of the food there is a loss of at least a fourth of the total amount. Part of this loss is, of course, due to shrinkage and deterioration in the storing and handling of the materials, but the larger part of it occurs in other ways. From the data collected in the dietary studies it was found that on an average the patients rejected 18 per cent of the total amount served to them and the attendants 22 per cent. This represents only the part of the food that was rejected on the plates, and does not include the excess of food brought into the dining room over the amounts served to the individuals at the table. The latter made a small but appreciable proportion of the food sent from the kitchen to the dining room, and being commonly too small to be returned to the kitchen and utilized in "made-over" dishes, it usually went with the wastes from the plates, so that the total waste from the dining rooms would be even larger than the figures given, or averaging about 25 per cent for the whole institution, as near as can be estimated from the data obtained in the studies. In the studies in the New York hospitals for the insane the corresponding average waste was found to be about 30 per cent. In studies with private families the waste has sometimes been found to be as high as 8 or 10 per cent of the total food purchased, and in boarding houses 20 per cent has been noted in exceptional cases. With large institutions it is more difficult to avoid waste than with families or with moderate sized groups.

In general it may be said that the Government hospital diet which was generous in kind and amount and well prepared furnished the patients and employees with quantities of protein and energy at least as large as the commonly accepted dietary standards for men with a similar amount of muscular work would indicate to be necessary. The amounts provided and served were in general considerably larger than the amounts eaten. So far as can be judged from the resuslt of these studies as compared with similar data obtained elsewhere, the dietetic management of the institution was very satisfactory. Opportunities for improvement were observed, but these have to do with details rather than with the system as a whole. In the detailed discussion of the investigations referred to (see p. 475), ways have been pointed out which would lead to a more economical use of the food supplied without in any way rendering the diet less attractive or reducing the amount below a proper allowance.

## FOOD REQUIREMENTS OF THE INSANE.

Some consideration of the requirements of insane hospital diet as a whole, and of the possibility of fixing upon satisfactory dietary standards for such institutions, will not prove without interest.

In providing food for the population of a hospital for the insane, two fundamental principles should be recognized. One is, that the kinds and amounts of food should be adapted to the actual physiological demand. The other is, that these demands differ with different classes of persons. A distinction between patients and employees and a classification of patients according to physiological demand are therefore desirable. Such a classification of patients, however, might not accord with either that based upon the diagnosis of the mental disease, or that which is recognized for convenience of hospital administration, or that which actually obtains at the tables of a given hospital. To the physiological chemist it might seem that the classification which the alienist makes by the nature of the mental disease and his own classification by physiological demand for nourishment might be brought into more or less accord. But it is evident that the exigencies of hospital administration do not always permit the assignment of patients to tables by such principles of division.

Regarding the actual physiological demand, as expressed in quantities of nutrients and energy of food, comparatively little is known. From available data it seems fair to conclude that the principal factor is the degree of physical activity. If this is the case, the principle would be the same for the insane as for people in normal mental condition. It is more than likely, however, that there are exceptions to this principle; that there may be classes of the insane who eat more and may actually need more than people in normal condition with corresponding physical activity, while it is also probable that there are other classes who need less food than the normal amount.

It has been suggested that one of the important functions of the brain is to regulate the metabolism. There seems to be evidence that there are mental states in which this regulation is abnormal, but we have as yet no very clear idea as to the nature of that regulation when it is normal or the conditions which make it abnormal or the effect of any given form of mental disease in this respect. So true is this that any attempt to discuss the principle is largely a use of words to cover ignorance. Perhaps the nearest approach we can make to a definite statement fitted to the present purpose is that there may be conditions in which the proper regulation of metabolism by the brain is so interfered with that the total metabolism of nutritive material is out of accord with the normal physiological need.

This leads us to distinguish between two ways in which the nervous system may exercise a control over the quantity of material metabolized in the body. The one is automatic, the other involves the action of the will, either consciously or instinctively. This latter is touched upon beyond (p. 481). It is the former, the automatic regulation, which was referred to in what was just said. Whether this regulation is exercised from nerve centers within or outside the brain is not material for this discussion. The point is this: Such forms of metabolism as the cleavage of proteids of either food or protoplasm, which accompanies muscular exertion, or the oxidation of carbohydrates or fats by which the energy potential in these compounds is made kinetic and available for that muscular work, are somehow under the control of nerve centers or at least largely influenced by them. In normal bodily conditions, and with a normal supply of food material, that control is so exercised that the quantity of material metabolized is more or less nearly proportional to the muscular work done. It is possible that there may be forms of mental disease in which the control of metabolism by the nervous system is interfered with, so that the amount of material metabolized does not accord with the demand. In such cases, if they occur, the body might transform a much larger amount of material in order to accomplish a given amount of work than would be necessary if the regulation were normal. Such a theoretical condition might be compared to that of a manufacturing establishment in which the engineer should fail to do his duty and consequently the amount of coal burned in the furnace to keep the machinery in motion would be excessive. People in such condition might need more food than those in mental health with corresponding physical activity. The experienced gained in the investigations carried on at the Government hospital and elsewhere, however, has not shown any form of mental disease or any class of the insane to which this description would apply. In other words, no class of patients was found whose food requirements seem to be in excess of the demand due to muscular or mental activity.

To this last statement, however, there is a possible exception. It is believed by some hospital physicians that there are terminal dements who digest their food less completely than if they were in normal health, and hence, in order that the amount actually absorbed may be sufficient to meet the physiological demand, they may require more food than would otherwise be necessary. The way to test this question would be by comparing the food eaten with the residue excreted by the intestines. So far as the writer is aware, no quantitative experiments have been published in such form and number as to settle this question. Without them it would be unwise to pronounce a judgment as to whether the imperfect digestion of food by patients of this class would be sufficient to materially increase this requirement. However, in view of what has been actually learned of the food consumption of people of this class it seems fair to question whether there is much real ground for assuming that terminal dements as a class need more than the small quantity of food which their low physical and mental activity would naturally call for.

This is equivalent to saying that thus far no such theoretical consideration or attested results of experience have been found which would seem to warrant the statement that the insane require more food than people in mental health with corresponding activity.

The statements so far made refer to the automatic regulation of metabolism by the nervous system. There is, however, a voluntary control of the amount of food consumed. The control thus exercised may be either instinctive or intentional, but with people in normal condition it is a most important factor in regulating the food consumption. When a man is in mental health, his judgment or instinct, or both, tell him more or less accurately when he has eaten enough, but the person with imperfect mental development, as the idiot or imbecile, may be without even the instinctive consciousness that his needs are satisfied. If the food is set before him he may continue to eat as long as the comfortable feeling continues, even if in so doing he eats to a great excess. Such persons may seem to need large quantities of food, but it is doubtful whether this is an indication of real physiological demand and whether it may not be an injury and hence a wrong to the patient to allow him to gratify this inclination.

On the other hand, there seem to be indications that a loss of mentality may be accompanied by diminished physiological demands for nutriment. Certainly the instances noted in connection with the investigations in the New York State hospitals of the diet of patients of the infirm class, a large number of whom were vegetative dements, showed that the quantities of food eaten were so small as to suggest that when low mental activity thus occurs with low physical activity the food requirement is reduced to a minimum.

To the layman it might seem that some classes of patients, especially the chronic disturbed, who apparently labor under considerable mental agitation, might require unusually large quantities of food; but it is a question whether hospital experience supports this assumtion.

Taking the facts thus far found, it seems fair to conclude that the physiological demand of the insane for nutriment, so far from being larger, is, on the whole, rather smaller than that of people in mental health. This, however, should be accepted as a present impression and not as a generalization warranted by long-continued and accurate test.

## FOOD CONSUMPTION VERSUS PHYSIOLOGICAL DEMAND.

It is often assumed that the appetite may be taken as a measure of the quantity of food that should properly be eaten. If this is true in some cases it certainly is not true in all. With most people the amount eaten is influenced largely by the taste of the food and the habits of the eater. Physicians and hygienists are very generally of the opinion that a large proportion of the well-to-do people in this country eat more than is necessary, and this opinion is certainly borne out by statistics of food consumption. But even assuming that people of sound mind have such good judgment and self-control and freedom from bad habits of eating that their appetites and inclinations will adjust their diet to the actual demands of their bodies, irrespective of the attractiveness of the food they find in the market and on their tables, we could hardly assume that people whose judgment, acquired habits, and self-control are as unreliable in other respects as is the case with many of the insane could be depended upon to make the wisest choice in so delicate and difficult a matter as the adjustment of nutriment to physiological needs. It seems fair to consider that large numbers of the insane are inclined to eat thoughtlessly. As a matter of fact, they seem to eat whatever is set before them, asking no questions and taking no thought as to whether or not it is more than they need, so long as hunger is satisfied and no physical discomfort is felt.

Man, like other animals, can dispose of much more food than is needed for his sustenance. The less his understanding of his physical needs the more ready is he to eat unwisely. It would seem that the question may be safely asked whether the administering of foods to some classes of insane people is not very much like the feeding of animals. If this be so, it would be only natural to expect that so long as the food is supplied to them they will eat a great deal more than is really needed. Of course account must be taken of the patients who are disinclined to eat and may be underfed unless they have special care, and it may be that many patients would give no indications of dissatisfaction if less food were supplied them than they actually need.

The matter may be put in another way. Excessive eating is injurious to health. The same is true of insufficient nourishment.

People of sound mind guard themselves more or less against the evils of excess or deficiency, though many fail to do so and suffer in consequence. A considerable part of the population of the hospitals for the insane can not be expected to exercise any such good judgment. If they are fed without regard to their needs, the natural result in many cases would be excess. Such feeding is uneconomical from the standpoint of hospital administration, if not injurious to the patient himself. It may be that others eat too little, though the observations reported in the recently published bulletin of this Office [a] and in the account of studies in the New York State hospitals would indicate that the amount of food supplied to patients could hardly be considered deficient.

## PHYSIOLOGICAL DIETARY STANDARDS.

This brings us to the consideration of the question, What are the physiological demands of the different classes of the insane? Our present knowledge of the actual needs of insane hospital patients of different classes is insufficient. We have quite generally accepted physiological standards for persons in health of different age, sex, and occupation, but considerable accurate observation and experiment will be needed to establish reliable and satisfactory standards for people in abnormal mental and physical conditions.

With the insane, as with others, it is important to distinguish between different classes and learn the needs of each class. One important part of the investigation at the Government hospital was to find out the quantities of food actually eaten by patients of different classes and different sex.

In lack of exact information as to the actual needs, the best that can be done is to make as accurate estimates as possible. As data for those we may use:

(1) Dietary standards for persons in health, taking into account the facts upon which the standards are based and what is known of the relation between age, sex, size, and especially occupation, physical and mental, on the one hand, and the demands for nourishment on the other.

(2) What can be found concerning the probable demands of different classes of the insane, as compared with those persons in health.

### DIETARY STANDARDS FOR PERSONS IN HEALTH.

Taking into account the results of a very considerable amount of research concerning the actual food consumption of persons of different age, sex, and occupation, and under different conditions of environment, and the results of a large number of metabolism experiments, including those with the respiration apparatus [a] in Germany and those with the respiration calorimeter [b] in this country, it is possible to deduce certain values which appear to represent more or less closely the needs of persons under different conditions. These dietary standards, however, are at present based upon insufficient data, and a great deal of painstaking research will be necessary before any hard and fast rules can be laid down concerning the quantity of nutrients and energy best suited to average persons of different age, sex, and occupation. One subject now much discussed is the demand for protein. A considerable amount of observation and of well-attested experiment shows that people with little, and in some cases with not inconsiderable, muscular activity are content and apparently maintain good health with much smaller quantities of protein and energy than the current standards (European and American) call for. The questions of the function of proteids in nutrition and the actual needs by people of different classes, occupations, and environment demand much more thorough study than they have thus far received.

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[a] U. S. Dept. Agr., Office of Experiment Stations Bul. 150.

The standards tentatively proposed by the writer for adults, under ordinary conditions of health and environment, are as follows:

*Dietary standards for adults in health.*

| | Total protein. | Digested protein. | Fuel value of total diet. |
|---|---|---|---|
| | *Grams.* | *Grams.* | *Calories.* |
| Man with moderately active muscular work | 125 | 115 | 3,400 |
| Man with light to moderate muscular work | 112 | 103 | 3,050 |
| Man with sedentary work | 100 | 92 | 2,700 |
| Woman with moderately active work | 100 | 92 | 2,700 |
| Man with very little exercise | 90 | 83 | 2,450 |
| Woman with light to moderate work | 90 | 83 | 2,450 |
| Woman with very little exercise | 80 | 73 | 2,200 |

## DIETATY STANDARDS FOR THE INSANE.

The results of the dietary studies carried on in the different hospitals for the insane serve to indicate how much nutrients and energy the patients of different classes are ordinarily obtaining in the food actually eaten. The concordance of results for similar groups of patients in different hospitals is sufficient to show that their actual food habits are not greatly different.

The patients in the Government hospital at Washington consumed on an average a diet furnishing practically the same quantities of protein and energy as those in the diet of similar patients in New York State institutions. It does not seem that the inmates of either institution had less than they needed, if one may judge by their physical condition, the reports of attending physicians, and other available information. Basing our inferences upon what would appear to be the food requirements of persons in health and upon the actual food consumption in the majority of American hospitals for the insane in which dietary studies have been made, it would seem that the average hospital population would be amply nourished with a diet furnishing 90 grams of protein and 2,700 calories of energy per man per day, and very likely somewhat less would suffice for healthful nourishment. It is, however, better to err on the safe side, and to supply too much rather than too little; and for general practice it might be better to consider the physiological demands as requiring a diet supplying 100 grams of total (corresponding to 92 grams of digestible) protein and having a fuel value of 2,950 calories of energy per man per day. The corresponding data on the basis of "per person" per day, assuming the population to be approximately one-half women, would be 85 grams of the total, or 78 grams of digestible protein, and 2,500 calories of energy.

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[a] For a description of the respiration apparatus, see summary of results by Pettenkofer and Voit, Ranke, and others in U. S. Dept. Agr., Office of Experiment Stations Bul. 45, p. 265.

[b] See report of experiments by W. O. Atwater and associates in U. S. Dept. Agr., Office of Experiment Stations Buls. 44, 69, 109, and 136.

It is very important, however, to distinguish between the physiological standard which is intended to meet the actual demand for nourishment and the hospital standard or ration allowance, which must provide not only enough food to meet the physiological demands, but also an additional amount as margin to cover the shrinkage and waste.

The following table brings out more clearly the relation between the ration allowance and the proposed dietary standard, and shows the necessary ration allowance with different margin percentages. The basal amounts, i. e., the actual amounts of nutrients and energy in food consumed with no allowance for margin, are 85 grams of protein and 2,500 calories of energy in the dietary standard. If the ration allowance is based upon these figures with different percentages of margin the results given in the table are obtained.

*Proposed ration allowances per person per day, based upon the suggested dietary standard for the insane, with different margins for shrinkage, waste, etc.*

| Rations. | Protein. | Fuel value. |
|---|---|---|
| | *Grams.* | *Calories.* |
| Basal amount, no margin | 85 | 2,500 |
| Ration allowance on basis of 15 per cent margin | 100 | 2,950 |
| Ration allowance on basis of 20 per cent margin | 106 | 3,125 |
| Ration allowance on basis of 25 per cent margin | 113 | 3,350 |
| Ration allowance on basis of 30 per cent margin | 121 | 3,575 |

A certain amount of margin is necessary, though the amount is difficult to fix definitely. The margin necessary under the conditions now existing in most institutions can probably be reduced by improved methods of storage and handling of food and of kitchen and dining-room management. Just what margin the actual insane-hospital ration allowance shall assume to be necessary is a question of hospital administration and not of physiological chemistry. In view of this fact it would not now be desirable to set up a standard for hospital allowance.

In considering the question of hospital allowance the hospital officials should bear in mind that, in general, enough nutrients and energy must be added to the physiological standard to make up for the loss by shrinkage and waste.

## MARGIN ALLOWANCE FOR FOOD NOT EATEN—WASTE.

The estimates just given refer, it must be remembered, to the food actually eaten. The food actually supplied must be considerably increased, so as to cover the waste and shrinkage which, to some extent, must inevitably occur. Even in the best-regulated households not all of the food purchased is actually eaten. A certain amount of waste is inevitable—that is to say, more or less of the edible portion of the food is necessarily lost in the cooking and serving. According to the experience gained in a large number of investigations the loss in this latter way is generally larger in boarding houses, i. e., with moderate-sized groups, than in small families. Whether it need be larger in public than in private establishments can not be said. It was certainly large at the Government hospital, and in some of the other hospitals in which investigations have been carried on.[a]

It has been a matter of surprise to see in how many ways the wastes may occur and how much effort would be needed to prevent them. Nevertheless, it seems certain that it will prove possible to reduce waste very much. The first thing that is needed is to have the attention of the persons in charge called to the subject. The next step will be to observe just where the leaks are and how they may best be stopped. These leaks occur in the storeroom, the kitchen, and the dining room. Those in the storeroom are of less importance, but they could, at times, be obviated, especially if better storage facilities could be furnished in some instances. Those in the kitchen appear to be the largest. In the preparation of vegetables for cooking a good deal of the edible portion is removed, as, for instance, in paring potatoes and turnips. Oftentimes, considerable portions of food are left adhering to the pans in which they are baked, or in the water in which they are boiled. When the food is served at the table, the portions are not always fitted to the tastes and the eating habits of the individual persons before whom they are placed. Sometimes the portions left on the dishes from which the food is served and which are carried back to the kitchen are not worked up into palatable dishes and served again, as they might be. In many such ways as this wastes occur, and the aggregate is much larger than one would commonly think.

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[a] New York State Com. Lunacy Rpt., 11 (1898-99), p. 247; 13 (1900-1901), p. 114. Connecticut Storrs Sta. Rpt. 1899, p. 142.

To prevent waste entirely is impracticable, because some of it is inevitable. The best that can be done is to reduce it to a minimum. It is possible, even in large institutions, to provide for the utilization of food so that the losses shall be small. This can be accomplished by a better understanding of the nutritive values of food and of the demands of the people for nourishment, and by improvements in methods of storing, handling, and especially of preparing and serving the food. In this way it will be possible to provide more palatable and more attractive nourishment at lower cost. This was demonstrated in the course of the studies at the Government hospital. From time to time opportunities for improvement were pointed out to the late superintendent and were promptly acted upon by him, and he stated that, in his opinion, as a result of these investigations, the cost of the food during the last six months of the year in which the studies were made was lower than for any other corresponding period during his connection with the institution.

That a very material reduction in the amount of waste is possible is suggested by a study of the data showing the waste in the individual studies at the Government hospital. In many cases the waste was due largely to the fact that the menu was not entirely suited to the dietary habits or desires of the persons partaking. For instance, in one study, breakfast foods, meat stews, and leguminous soups were not relished; from a fourth to a third of the oatmeal and nearly a half of the hominy served were wasted. That the diet in the case here pointed out was ample is evident from the fact that in spite of such large waste of individual foods, the persons included in the study received fully as much of nutrients and energy as the average, judging by the values given above.

Similar facts were brought out in other studies. It would undoubtedly be possible to devise means for suiting the diet more nearly to the preferences and idiosyncrasies of the consumers in such cases, and at the same time effect a pecuniary saving. Such a condition has been observed in investigations made elsewhere. Thus Prausnitz, a prominent German physiologist, in speaking especially of the diet of hospitals, has pointed out the fact that in order to be entirely satisfactory a diet must conform to previously acquired food habits.

Mrs. Ellen H. Richards, in considering her studies of dietaries in institutions in Boston, has also observed that it is not enough to calculate the nutritive value of food, to have it cooked according to the best recipes, and served in the most attractive manner. The food must have a familiar appearance and taste, because people prefer that to which they are accustomed. Novelty in food does not commend itself to those who have been used to little variety. Therefore, for the most successful and economical feeding of persons in institutions it is essential to consider their previous dietary habits.

On the other hand, monotony in the diet is also to be avoided. Where the menu is repeated each week, as is common in institutions, the patients associate certain days with certain diets and become averse to the food before it is served. A less regular rotation of meals could be provided, and it would undoubtedly add to the attractiveness of the diet.

## FOOD STUDIES NEEDED.

### FEEDING EXPERIMENTS.

We can hardly emphasize too strongly the statement that it is impossible to assign accurate dietary standards for the patients of different classes in a hospital for the insane. The difficulty is that the observations are not yet sufficient. .It would not be difficult to make observations and special feeding experiments which would throw much light upon this important question. Such experiments are greatly needed, and it is hoped that they may be made in the near future. A well-regulated hospital for the insane affords a most excellent opportunity for such experiments, and they could be made without the least detriment or inconvenience to the patients, and the expense would be small in proportion to the value of the results. Until they are made, the best we can do is to assume that for the chronic insane, those who are past recovery, the physiological demand would be similar to that of people of sound mind and similar physical activity. The reason for this is found in the fact that the actual physiological demand of people in health, according to the best knowledge now obtainable, varies chiefly with the degree of muscular work. How special forms of intellectual activity and nervous tension affect the demand for food, either in mental health or in mental disease, we do not yet know, but it seems probable that with people in mental and physical health and without special demands for intellectual effort the average physiological needs are not far from those expressed in the current dietary standards. There is now much discussion among physiologists regarding the supply of protein and some are inclined to think that the current standards call for more than is actually needed, but, at any rate, it may be regarded as certain that the amounts suggested by these standards are abundant enough to exclude the idea of underfeeding.

Very little is definitely known regarding the food requirements of convalescents and others whose bodily health is not normal. Judged by the diet generally prescribed, the consensus of opinion of physicians seems to be that it should be as generous as the patient can utilize without overtaxation of the digestive and assimilative functions, the idea evidently being that the tissue waste and exhaustion of illness may be quickly repaired by an abundant supply of building material.

How far the plane on which a man is nourished affects his general well-being, his resistance to disease, and his ability as a worker can not be settled without much further study. The idea is, however, generally held that a generous diet is more favorable to good results than the reverse. At least we often find that a continued low plane of living is attended by unfavorable results. A recent recognition of this is found in the agitation in England regarding the undernourishment of laborers and laborers' children. In view of these facts and other similar considerations it would certainly be unwise to restrict unduly the food supply of hospital patients in any way that might lessen their chance of recovering or diminish their physical resistance to the advance of disease. It is fitting, therefore, that dietary standards which are certainly generous should be selected for purposes of comparison.

As regards the insane, the important distinction is to be made between the acute—that is, those who may recover—and the chronic—that is, those who are past recovery. For those who may recover it would be hardly wise to lay down rules for diet based solely upon quantities of nutrients and energy. The treatment of these, like the treatment of the sick in general, is a matter for the expert physician. To provide fitting and ample diet for such patients is the plainest and most pressing duty.

If a large number of feeding experiments could be made with different classes of patients in hospitals for the insane, it would be possible to secure much of the data needed for fixing upon the best dietary standards.

## DIETARY STUDIES.

The work at the Government hospital represents the second kind of research needed, though it naturally comes first in order of time. Its chief feature, as has already been explained, was a study of the amounts of food actually eaten by the hospital population and a comparison of these amounts with the amounts purchased and those served at the table. The results of these dietary studies show decidedly that the amounts supplied much exceeded the actual demand for nourishment. They do not yet show exactly what is this physiological demand, but they help indicate how it may be determined. They also help to bring out more clearly the ways in which the dietaries may be improved while the cost is diminished. They lead to a number of inferences, among which are the following:

(1) The physiological demand for nourishment, which should be the basis of a dietary standard for the hospital dietary, can be found only by actual observation and experiment.

(2) The actual food supply must be in excess of this physiological demand, the difference between the two being found in the inevitable shrinkage and waste in the storeroom, kitchen, and dining room.

(3) The actual shrinkage and waste are much larger than is commonly supposed. They can be reduced by improved methods, especially those of cooking and serving the food.

(4) In like manner, the food should always be made attractive to the eye and the taste, nutritious, and adapted to the special wants and habits of patients of different classes.

## PREPARATION OF FOOD AND MENUS.

In connection with nutrition investigations there is opportunity for much useful work in devising ways of cooking and serving foods and of making attractive dishes from left-over materials which might otherwise be wasted; since such foods, though perfectly wholesome, are not of such a character that they could readily be served again in their original form. In the home many of the most palatable dishes are made from simple and inexpensive ingredients, and in part, at least, from some food remaining after the family has been served. The proper preparation of such dishes frequently requires considerable time and care. A recipe which perhaps gives a very satisfactory dish when prepared for a small family is not always easy to use under conditions where food must be cooked for a large group. This is due in part to the fact that large quantities often require special methods of mixing and handling, and there are other considerations which will be readily appreciated by those who are familiar with the practical problems of cookery. It is obvious that the time required for preparation must not be excessive, otherwise the final cost of the dish made of inexpensive ingredients may be out of all proportion to its attractiveness or nutritive value. It is in devising ingenious ways of meeting such problems as are suggested above that the expert dietitian has an abundant opportunity for useful work in connection with studies of institution dietetics.

At the time of the New York State hospital dietary studies some work of this character was undertaken and proved very useful. Recipes for a number of dishes were suggested, printed on leaflets, and distributed to the various hospitals for trial. The results were highly satisfactory and made it evident that much good would come from a continuation of such work. Much useful information along such lines has of course been accumulated by institution dietitians, some of which has been made accessible by publication.

The devising of menus of such a character that an attractive meal is provided is another matter requiring skill and judgment. It is obvious that if economy is sought the major portion of the meal must be composed of inexpensive foods, with just enough of the more attractive and perhaps more expensive foods to render the whole palatable. This does not by any means imply that the inexpensive foods are necessarily unpalatable. Bread is one of the most economical foods and would perhaps be as much missed from the diet as any single article, yet bread is made much more palatable to the ordinary individual by the use of a small portion of butter, which is, pound for pound, considerably more expensive than the bread. In ways like those suggested the person with a thorough knowledge of the principles of nutrition, the nutritive value of foods, and skill in their preparation can do a great deal to render the diet of institutions attractive without adding unduly to its cost. Preliminary experimenting is required and should form a part of future investigations connected with institution dietetics.

## CONCLUSION.

The above discussion does not imply that there is anything especially at fault in the present management and methods of the Government hospital or that there is call for radical or sudden change. Indeed the conditions there are evidently in many ways much above the average. It means that in general, so far as appears from studies made in a large number of hospitals for the insane, the condition of affairs in this department of hospital service is just what is found in the different departments of many large establishments, as in manufactories and railroads, where the progress of the times demands better equipments, accommodations, and products, and where closeness of competition and increasing needs require more careful economies. The increase of scientific knowledge and practical experience shows how improvements may be brought about in hospitals as well as in business and commercial enterprises. The condition which has been found to prevail in hospitals for the insane is not one for serious criticism nor is anyone especially to blame for the deficiencies. The improvement is simply what ought to come in the natural course of events. The only blame would be where there is failure to make the needed effort toward improvement.

Economy in the food expenditures of institutions is desirable, but it should always be remembered that a reduction of the cost of the dietary is not the only object, nor even the chief object, of an inquiry like those which have been carried on in Connecticut, New York, and Washington, D. C. Humanitarian considerations are of far higher consequence. Some of the inmates of the hospitals may be cured, and everything possible should be done by diet or otherwise to facilitate their cure. Of the incurables a large proportion have a keen appreciation of the comforts and discomforts of their condition, and their sources of enjoyment are necessarily so restricted that, with a large proportion, the pleasures of eating are probably paramount. To alleviate their discomforts and to provide as much as possible of the things which contribute to their happiness is a most evident duty, and these ends may be served, in part at least, by fitting the food to the needs of the body and rendering the diet attractive and palatable.

What should be especially pointed out here is that if investigations like those which have been undertaken can be properly continued it will be possible to learn much concerning the ways in which the food may be better adapted to the actual needs of the patients of different classes and to devise improvements in the planning of menus and in the preparing and serving of the food which will fit it better to the varying tastes of the hospital population and at the same time prevent unnecessary waste. The outcome will be advantageous in at least three ways: (1) Hospital life can be made, in part at least, less wearisome to the patients; (2) dietetics can be managed more in accord with the demands of hygiene; and (3) the food supply can be more economically used, thus reducing the cost of the diet.

# EXPERIMENT STATION WORK IN CORN CULTURE.

By J. I. Schulte, *Office of Experiment Stations.*

The corn crop constitutes the actual basis of American farming. It is of value as a bread, a forage, and a fallow crop. It is grown in every State and Territory, the area ranging from several thousand acres in some to as many millions in others. The principal corn-growing States harvest from 200,000,000 to 300,000,000 bushels annually, and the total yearly yield of the entire country amounts to over 2,000,000,000 bushels.

The attention given the crop by the experiment stations has been and continues to be in proportion to its importance as a national resource. From the time the stations were established investigations on the different phases of corn culture have been carried on, and data showing the results obtained under different conditions have accumulated. The literature on the subject issued by these institutions in the form of bulletins and reports is very extensive. The lines of investigation have always been directed by existing needs, and as a good example of this fact the work with varieties may be cited. The earlier work of the stations was most largely in the direction of determining the relative yielding capacity of different varieties, but as the data increased and the best varieties for different localities and conditions were singled out, attention was turned toward the improvement of these varieties in productiveness and chemical composition, and most promising, and, in fact, epoch-making, results have already been obtained. It is of interest to note along what lines the experimental work has been carried on, the progress that has been made, and the influence the results have upon the corn production of the country at large. The numerous publications at hand treat of soil preparation, planting, cultivation, root pruning, detasseling, irrigation, rotative and continuous cropping, development of the root system, different methods of harvesting, improvement of varieties, composition of different parts of the plant, the uses and value of the crop in feeding, either as green fodder or silage, and diseases and insect enemies, together with numerous other lines of work.

The presentation of the results covering the whole subject of corn production for a series of years is necessarily more or less fragmentary, and the object of this article is to bring the matter together for comparison and study. The progress and achievements of the movement can best be shown in this manner. This article is limited to the discussion of what may be called the cultural work with corn, and such subjects as diseases, insect enemies, and feeding value of the crop have been omitted. Feeding experiments have been carried on very extensively, and this phase of the subject, in order to do it justice, requires separate treatment.

### CORN IN CROP ROTATIONS.

Corn is a cleansing crop, and for this reason, as well as its universal culture, lends itself most admirably to American crop rotations. It has quite generally entered into the rotation experiments of the experiment stations, but the results are usually reported as showing the benefit accruing to the soil from the rotation as a whole, and in only a few instances do they show a direct and definite bearing upon the crop itself.

At the Indiana Experiment Station[a] rotation experiments begun in 1880 and carried on for fifteen years have shown how the yields of corn may be affected by continuous grain culture and by growing grain in rotation with timothy and clover. On one series of plats corn, oats, and wheat were grown in rotation with each other, while at the same time on another series these same crops were grown in rotation with timothy and clover. No manure or fertilizer was used, in order that the results might show more clearly the relation of the rotation to the yield of corn. The yields obtained from year to year were in favor of the rotation, including timothy and clover, and in one season the difference amounted to 10.67 bushels per acre.[b] It was also observed that the productive capacity of the all-grain plats decreased much more rapidly than that of the timothy and clover series. In 1895 the results for the preceding nine years showed an average increase of 22 per cent in the yield of corn in favor of this same series. In 1896 both series of plats were plowed and planted to corn, and the yields for the all-grain and timothy and clover plats were 48.42 and 54.08 bushels per acre, respectively.

The influence of crop rotation on the yield of corn is also indicated in the results of rotation experiments begun at the Illinois Station in 1876.[c] The average yield in 1893 for the last six years of the test on a plat continuously in corn and receiving barnyard manure annually was larger than the yield on plats growing corn, oats, and clover in rotation without fertilizers of any kind, but a similar plat receiving no fertilizer treatment yielded much less than the plats under rotation. It was shown that continuous corn growing on unmanured land reduced the fertility of the soil, while corn growing in rotation with oats had the same tendency, but apparently to a lesser degree.

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[a] Indiana Sta. Bul. 64.

[b] Indiana Sta. Bul. 55.

[c] Illinois Sta. Bul. 31.

Commercial fertilizers applied annually in continuous corn growing did not bring the yield up to the results on the rotation plats, or even to the results on the plats growing corn and oats alternately. In 1894, in this same experiment,[a] corn grown in rotation with oats and clover yielded 40 per cent more than corn in continuous culture. In 1895 the land under the rotation containing clover again gave decidedly superior yields as compared with the land under other methods of cropping without the use of manures or fertilizers.

The effect of corn culture on the succeeding crop was shown in experiments at the South Dakota Station,[b] in which the difference in the yield of wheat following corn and on summer fallow was only one-third of a bushel per acre. In another trial in an unfavorable season an increase of 16.12 bushels of oats per acre was obtained where this crop was grown after corn instead of after wheat.

At the North Dakota Station[c] corn proved to be a good rotation crop for wheat and flax. In a very dry season the yield of wheat after wheat on fall-plowed land was 5 bushels per acre, and on land which had produced a crop of corn the year before, 24.6 bushels. In a very wet season wheat after wheat gave 21 bushels per acre, and after corn, 22 bushels, and on summer fallow, 18 bushels. A marked increase in yield in the dry season is ascribed to the conservation of soil moisture connected with corn culture.

A soil test at the Connecticut Storrs Station[d] conducted for twelve years, in which different crops were grown in rotation, showed that the nitrogen and phosphoric acid applied in the fertilizers were most effective where corn entered the rotation.

## VARIETIES.

Varieties of corn have been tested by nearly all experiment stations, and the following are among those which have been most productive in different localities:

*Dent varieties.*—Yellow: Early Yellow Rose, Leaming, Legal Tender, Reid Yellow Dent, Champion Yellow Dent, Golden Beauty, Golden Eagle, Cloud Early Yellow, Murdock, Nickle Plate, Stewart Improved, and Riley Favorite. White: Cocke Prolific, White Rockdale, Blount Prolific, Hess White, Burr White, Red Cob Ensilage, Champion White Pearl, Calhoun Red Cob, Huffman, Mammoth White Surprise, White Superior, Mosby Prolific, Iowa Silver Mine, Welborn Conscience, Boone County White, St. Charles White, and Shaw Improved.

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[a] Illinois Sta. Bul. 37.

[b] South Dakota Sta. Bul. 79.

[c] North Dakota Sta. Bul. 51.

[d] Connecticut Storrs Sta. Rpt. 1901, p. 127.

*Flint varieties.*—King Philip, Triumph, White Flint, Longfellow, Angel of Midnight, North Dakota, Mercer, Will Gehu, and Sanford.

The Illinois Station[a] considers Reid Yellow Dent, Golden Eagle, Iowa Silver Mine, Riley Favorite, White Superior, Leaming, and Boone County White as standard varieties for Illinois.

A summary by the Mississippi Station[b] of the comparative yields of yellow and white varieties of corn from seven corn-growing States, the flint and flour varieties being excluded, shows that in 1,267 tests with 490 varieties the average of 217 white varieties has been 2.5 bushels per acre in excess of the yield of 273 yellow varieties, and that at only one of these stations have the yellow varieties given the better average yield. A compilation of analyses made by the Pennsylvania Station[c] shows that the difference in composition of the yellow and white varieties is too small to be of any significance.

At this same station,[d] in a comparison of a flint and a dent corn for soiling purposes the dent variety gave an average yield of 45 per cent more dry matter than the flint corn, but when fed whole to cattle there was a waste of 12½ per cent of the dent corn, while all of the flint corn was eaten. It was shown that the flint corn was less woody and richer in protein than the dent variety. In Maine[e] Southern White Dent gave larger yields for an average of five years than a Maine variety of flint corn, but the quality was not so good, and, in general, the flint corn was more profitable.

The results of three years' experiments at the Indiana Station[f] led to the conclusion that varieties which yield most grain produce less stalk, and that early maturing varieties yield a larger proportion of grain to stalks than the late sorts.

The results of variety tests at the different stations show wide fluctuations in yield with the same variety in different years and even in the same field, and often large yields are obtained from comparatively little-known sorts. The Illinois Station[g] found that a variety planted on thirteen different plats scattered throughout the trial area ranged from early to late, and varied in yield from 45.8 to 100.8 bushels per acre, showing that all variations in yield can not be safely accredited to varietal differences. Data for thirty-four varieties grown from one to five years at the Indiana Station[h] show a range of thirty-three days in the time required to mature the several varieties, of 44 bushels of corn and over 3½ tons of stalks in the average yield per acre of the field varieties, of 24 per cent in the average proportion of stalk and ear, of 7.3 per cent in the average proportion of shelled corn, of 23.4 per cent of shrinkage in curing, of 18 per cent in the proportion of barren stalks, of 17 per cent in the proportion of stalks affected with smut, and of 43 per cent in the proportion of stalks both smutted and barren.

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[a] Illinois Sta. Bul. 63.

[b] Mississippi Sta. Bul. 33.

[c] Pennsylvania Sta. Rpt. 1895, p. 11.

[d] Pennsylvania Sta. Rpt. 1891, p. 26.

[e] Maine Sta. Bul. 11, 2d ser.; Rpt. 1893, p. 57.

[f] Indiana Sta. Bul. 55.

[g] Illinois Sta. Buls. 42, 46.

[h] Indiana Sta. Bul. 43.

At the Illinois Station[a] mixtures of two and four varieties gave larger yields in two years out of four than these same varieties grown by themselves.

### SEED.

Experiments conducted at a number of stations with kernels from the butt, middle, and tip portions of the ear showed but little difference in yielding capacity. Tests of this kind were made at the Ohio Station[b] during a period of nine years. Each year seed was taken from the butts of ears grown from the butt grains, and, in like manner, middles from middles and tips from tips. The results differed, but immaterially. Results obtained at the Kansas Station[c] for five years also showed but little difference in yield from seed taken from different parts of the ear.

Samples of seed corn obtained from 18 different States in 1898 and from 20 in 1899 were compared at the Arkansas Station.[d] The seed represented 10 Northern, 7 Middle, and 3 Southern States, and 11 varieties. The difference between yields of the same variety from different sources in the same latitude was sometimes greater than the average difference between varieties from different latitudes. The yields from seed of Golden Dent grown in the North varied from 15.9 to 48.8 bushels per acre. The results of two years' work indicated that seed corn grown in the same or nearly the same latitude as that in which it is to be planted will give the best results. At the Alabama Station[e] seed corn from Illinois gave a smaller yield than seed corn grown in the South, and in a second test seed corn from Virginia seemed to be more productive than seed from Illinois, Delaware, Georgia, and Alabama. At the Tennessee Station[f] seed from the North gave smaller total yields, but a higher percentage of grain than southern seed. Several of the northern varieties ripened in 97 days, while 119 days were required to mature the best yielding southern varieties. At the Michigan Station[g] seed from a well-ripened crop and from one not fully as mature was planted for comparison. The total yield from the well-ripened seed was 19,134 pounds per acre as compared with 17,210 pounds for the other. The effects of continued use of immature seed corn were studied for five years by the Wisconsin Station,[a] and it was found that very immature seed corn gave smaller yields of corn and stalks and slightly earlier maturity than the fully matured seed. The largest yields in the tests at this station were obtained from seed corn gathered slightly immature.

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[a] Illinois Sta. Buls. 25, 31, 37.

[b] Ohio Sta. Bul. 78.

[c] Kansas Sta. Bul. 64.

[d] Arkansas Sta. Bul. 59.

[e] Alabama College Sta. Bul. 88.

[f] Tennessee Sta. Bul., Vol. XIV, No. 1.

[g] Michigan Sta. Bul. 154.

The effect of fungicides on the vitality of seed corn was studied by several stations. The Vermont Station[b] found that seed of low vitality was injured by treating with water heated above 120° F.; below that temperature the treatment seemed beneficial. With another variety no perceptible effect, even from a higher temperature, was noted. Soaking the seed in Bordeaux mixture was somewhat beneficial. Soaking for fifteen minutes in copper sulphate solution had no effect, but when this treatment was continued for an hour or longer the seed was injured. The Ohio Station[c] concluded that the treatment of seed corn with hot water at 132° F. for fifteen minutes or a one-half per cent solution of potassium sulphid is to be recommended for hastening the germination and inducing the plant to pass as quickly as possible the period of greatest vulnerability to smut infection, namely, the early stage of the seedling when it is extremely delicate. At the Kansas Station[d] it was found that the germination of corn was scarcely affected when treated with a 10 per cent solution of potassium acetate for 24 hours, a 0.5 per cent solution of potassium cyanid for 1 hour, a 10 per cent solution of potassium sulphid for 24 hours, a 10 per cent solution of sodium acetate for 24 and 48 hours, and a 10 per cent sodium sulphate solution for 24 and 48 hours. The effect of the fungicides upon the vitality of the seed was shown first by the germination being retarded, then by the percentage of germination being lowered, and finally by the entire prevention of germination. In general, the effect upon the seed was proportional to the time of soaking and the strength of the solution.

### PLOWING AND SUBSOILING.

The work with plowing and subsoiling has given widely varying results in different seasons and at different stations. Subsoiling, as a rule, was of little importance under favorable soil and moisture conditions. Subsoiling at the Georgia Station[e] gave no material increase in yield, in one test a difference of only 0.89 bushel per acre being recorded. Red upland[e] with hard clay subsoil plowed to a depth of 5 inches and subsoiled 5 inches deeper, showed in each case a small loss from subsoiling on fertilized plats, as compared with plats not subsoiled, but on unfertilized plats there was an increase of 3.09 bushels per acre in favor of subsoiling. At the South Carolina Station[a] subsoiling the seed furrow did not improve the crop. Plowing land 4 inches deep at the Alabama Canebrake Station[b] yielded 24.1 bushels per acre with the corn planted in beds, and land plowed 10 inches yielded 24.2 bushels with the corn planted on the level. Subsoiled plats at this same station in 1903[c] produced on an average 2.5 bushels per acre less than plats not subsoiled. The season was very wet, and no material difference resulted from different methods of preparing the soil. In experiments at the Michigan Station[d] one of three plats of sandy soil was plowed 4 inches deep, while the other two were plowed 8 inches deep, and one of these was subsoiled 6 inches below the furrow. In 1895 and 1896 all plats were planted to corn; the second year the depth of plowing for all plats was 6 inches. The first year, which was unusually dry, the subsoiled plat produced a slightly better yield than the plat not subsoiled; but the second year, which was unusually wet, there was no apparent gain. Experiments in subsoiling were carried on for several years at the Nebraska Experiment Station[e] and the results obtained on a loam containing alkali and underlaid with a compact subsoil showed that subsoiling increased the yield in most cases, but when the season was very wet it failed to show any benefit. In the western part of the State subsoiling where the subsoil was loose and porous reduced the yield by about one-half. Fall plowing gave generally better results than spring plowing, and plowing early in the fall or in the summer was more effective in increasing the yield than plowing late in the fall. The benefits resulting from fall plowing are considered due to the fact that the fall-plowed soil is more compact in the spring than spring-plowed soil. Land plowed 4 inches deep, either in the fall or the spring, gave a better yield than land plowed 8 inches deep, and disking 3 inches deep in the fall gave better results than disking 6 inches deep, but it was not as effective as shallow plowing. Subsurface packing the soil according to the Campbell method of soil culture decreased the yield when it was done in the fall, but produced an increase when done in the spring. In cooperative tests throughout the State the results showed that on clay subsoil 80 per cent of the trials were favorable to subsoiling, but on a loam subsoil only 23 per cent. In eight cases of the fifty-nine reported the effect of subsoiling was unfavorable the first year, but favorable afterwards, and in four cases the beneficial results disappeared by the third year.

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[a] Wisconsin Sta. Rpt. 1900, p. 297.

[b] Vermont Sta. Rpt. 1891, p. 138.

[c] Ohio Sta. Bul., Vol. I, No. 3, tech. ser.

[d] Kansas Sta. Bul. 41.

[e] Georgia Sta. Buls. 10, 20, 23, 37.

Of sixteen cooperative tests with deep and shallow plowing for corn in different sections of the State, under the direction of the Nebraska Experiment Station,[a] nine gave an increased yield from deep plowing and three from shallow plowing, the other tests remaining indifferent. In eight of the tests the corn suffered more from drought on the shallow than on the deep plowing. In 1890 the Illinois Station[b] obtained 56.4 bushels of corn per acre from land which was not plowed but only disked shallow, 59.9 bushels from land plowed 2 inches deep, 69.4 from plowing 4 inches deep, 69.3 from plowing 6 inches deep, and 71.7 from plowing 8 inches deep. In 1891 no very great differences were obtained from plowing land 2, 5, and 10 inches deep. At the Indiana Station[c] the average yield for three years was but slightly different for land plowed from 4 to 12 inches deep, while the best general results are reported by the Oklahoma Station[d] from plowing about 6 inches deep and subsoiling 4 inches lower. The effect of the depth of plowing on the yield of corn was also studied by the New Hampshire Station[e] by fall-plowing a series of plats 3, 5, 7, and 9 inches deep. The plats were similarly prepared in the spring and planted to Leaming corn. During the latter part of the season the deeper plowed plat showed the most vigorous and strongest growth. At the time the corn was put into the silo the plat plowed 3 inches deep yielded 14.2 tons of fodder per acre; that plowed 5 inches, 26.2 tons; 7 inches, 29.4 tons, and that plowed 9 inches, 28.2 tons per acre. It is concluded from the experiment that for a deep soil deep fall plowing is preferable to shallow plowing for corn, while with an impoverished soil deep plowing can not be practiced.

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[a] South Carolina Sta. Rpt. 1889, p. 256.

[b] Alabama Canebrake Sta. Rpt. 1897, p. 10.

[c] Alabama Canebrake Sta. Bul. 21.

[d] Michigan Sta. Rpt. 1896, p. 114.

[e] Nebraska Sta. Bul. 54.

## MANURING.

In general, on the more fertile soils of the Central and Western States the use of commercial fertilizers for corn is not profitable at present. Barnyard manure, as a rule, increases the yield and shows good residual effects, but may not be profitable under all conditions. In the Eastern and Southern States, however, manuring with barnyard manure or commercial fertilizers or with combinations of both is quite generally profitable. Numerous experiments show that, on the whole, a complete fertilizer containing phosphoric acid combined with small amounts of nitrogen and potash is most likely to give good results. Experience shows that definite rules for the use of fertilizers on corn can not be given. The results of fertilizer experiments made by a number of experiment stations and here summarized bear out this conclusion.

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[a] Nebraska Sta. Bul. 64.

[b] Illinois Sta. Bul. 20.

[c] Indiana Sta. Bul. 50.

[d] Oklahoma Sta. Bul. 36.

[e] New Hampshire Sta. Bul. 71.

At the Connecticut State Station[a] in connection with growing corn continuously for six years on the same land treated with different kinds of manures or receiving no fertilizer whatever it was found that the sixth season, on land well supplied with plant food from cow and hog manure and from chemical fertilizers, the crop removed on an average 63.8 pounds of nitrogen, 19.9 pounds of phosphoric acid, and 52.4 pounds of potash per acre as compared with 29.8, 8.9, and 10.7 pounds of nitrogen, phosphoric acid, and potash, respectively, on the land receiving no fertilizer treatment. Liberal manuring with barnyard manure at this same station[b] largely benefited the yield of corn grown continuously on the same land, and also increased the ash and albuminoids in the crop without a similar effect on the fat and fiber. In kernels there was a marked increase in the protein and fat. A complete commercial fertilizer produced similar but less pronounced results. At the Connecticut Storrs Station[c] the largest yields, but not always the largest profits, were obtained from complete fertilizers containing a relatively small amount of nitrogen, or from 20 to 50 pounds per acre. Later results[d] indicated that mineral fertilizers were very essential to corn but insufficient when used alone, the addition of this quantity of nitrogen per acre in the form of nitrate of soda being beneficial. The omission of nitrogen from the fertilizer application at the Massachusetts State Station[e] produced light-colored kernels and decreased the yield. In experiments extending over a period of eleven year at the Massachusetts Hatch Station[f] barnyard manure alone gave slightly better results, though at a greater cost, than when commercial fertilizers were used. At this same station[g] a fertilizer application furnishing the same amount of plant food as an application of 1,800 pounds per acre, containing 2.35 per cent of nitrogen, 10 per cent of phosphoric acid, and 4.3 per cent of potash, was compared with applications containing slightly more nitrogen, much less phosphoric acid, and considerably more potash. The results were in favor of the application containing the smaller quantity of potash. This series of experiments carried on for ten years has shown that corn can be successfully grown on commercial fertilizers alone. Barnyard manure applied with potash was more profitable than barnyard manure alone. Potash has, in general, proved the most potent plant-food element in controlling the yield. In one series of experiments a plat which had received 160 pounds of muriate of potash per acre annually for fourteen years yielded in 1902[a] 47.7 bushels; a plat receiving 160 pounds of nitrate of soda in addition to the muriate yielded 53.4 bushels; one receiving 320 pounds of dissolved boneblack in addition, 55.9 bushels, while a plat receiving the three substances together gave a crop of 56.2 bushels. The highest yield of corn and stover in the series of the tests, however, was obtained on a plat receiving annually 5 cords of manure. Four plats which had not been fertilized for fourteen years showed a high degree of exhaustion.

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[a] Connecticut State Sta. Rpt. 1893, p. 286.

[b] Connecticut State Sta. Rpts. 1895, p. 216; 1896, p. 315.

[c] Connecticut Storrs Sta. Rpt. 1899, p. 168.

[d] Connecticut Storrs Sta. Rpt. 1901, p. 122.

[e] Massachusetts State Sta. Rpt. 1893, p. 221.

[f] Massachusetts Hatch Sta. Rpt. 1899, p. 9.

[g] Massachusetts Hatch Sta. Rpt. 1900, p. 114.

Phosphoric acid, either alone or with potash, gave profitable returns at the Delaware Station,[b] and muriate of potash, used either in part or wholly as a top dressing, gave a profit in seasons when other fertilizers were ineffective. The Maryland Station[c] has carried on a series of experiments to test the effect of lime on a rotation of corn, wheat, and hay. The applications varied from 10 to 60 bushels of lime per acre. The results for four years indicated that the smaller applications had proven as efficient at the end of the period as the larger applications and that the relative profits were in favor of the use of 20 bushels per acre. Other experiments by the station have shown that complete applications of fertilizers were needed on the soil under test, and that the use of lime had given a marked increase in yield. The use of ground oyster shells was much more effective than marl.[d] At the Virginia Station[e] phosphoric acid regularly gave increased yields at a profit, and nitrogen was used at a loss.

From the results of a series of years the Georgia Station[f] concludes that on the average soils of middle Georgia the commercial fertilizer application should contain available phosphoric acid, potash, and nitrogen in the relative proportions of 7, 1.3, and 3.4. On high, dry uplands all fertilizers were used at a loss. Nitrogen was the most effective element, and potash did not seem necessary. Composting cotton seed in the heap rather than in the furrow did not prove profitable. The station further found[g] that corn had no preference as to the source of nitrogen as between nitrate of soda, cotton-seed meal, and dried blood. The application of fertilizers in the drill generally gave better results than broadcasting. At the Florida Station[h] 200 pounds of acid phosphate, 125 pounds of cotton-seed meal, 75 pounds of nitrate of soda, and 100 pounds of muriate of potash were used as a standard application. This application, either increased or diminished by one-half, gave an increase in yield of 18 bushels per acre, and in the series of tests the use of one-half of the application was most profitable. On the soil of the Alabama Station[a] phosphates were especially effective and gave good results when used with crushed cotton seed and stable manure or muriate of potash. Among different fertilizer applications used at the Alabama Canebrake Station[b] in 1903, 88 pounds of nitrate of soda per acre given at the second cultivation gave the largest increase in yield. The same increase was obtained from 44 pounds of nitrate of soda and 100 pounds of cotton-seed meal given together at the first cultivation. The Mississippi Station[c] found that a complete fertilizer containing an abundance of vegetable matter was required on exhausted hill lands of yellow and red clay. At the Louisiana Station[d] nitrogen was especially needed, while potash was not required. Small amounts of phosphoric acid combined with nitrogen were profitable. Nitrogen with relatively small quantities of phosphoric acid and potash gave good results at the North Louisiana Station.[e] During five years' work on poor shallow upland soil with a stiff clay subsoil the Texas Station[f] found cow manure most profitable, although bone meal gave the largest increase in yield. On the black land at the McKinney Substation stable manure was the only fertilizer used at a profit.

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[a] Massachusetts Hatch Sta. Rpt. 1902, p. 128.

[b] Delaware Sta. Rpt. 1895, p. 229.

[c] Maryland Sta. Bul. 66.

[d] Maryland Sta. Rpt. 1891, p. 355.

[e] Virginia Sta. Bul. 31.

[f] Georgia Sta. Bul. 41.

[g] Georgia Sta. Bul. 55.

[h] Florida Sta. Rpt. 1901, p. 29.

At the Tennessee Station[g] 8 tons of barnyard manure per acre produced an increase of 22.10 bushels, 25 bushels of lime per acre increased the yield 20.09 bushels, and a complete fertilizer of 100 pounds of nitrate of soda, 150 pounds of acid phosphate, and 50 pounds of muriate of potash gave an increase of 18.31 bushels. These results were obtained with Cocke Prolific, while with Hickory King the yields obtained with this same treatment were but slightly increased. The Kentucky Station[h] determined that on the limestone soil of the bluegrass region potash was the element chiefly needed. Field experiments at the Ohio Station[i] in 1899 and 1900 indicated that the soils under test were most responsive to phosphoric acid and that without this element in the fertilizer nitrogen and potash were not effective. Next to phosphoric acid, nitrogen was needed and seemed most effective on soil showing the greatest deficiency in it by chemical analyses. It was also shown that where clover entered into the rotation the quantity of nitrogen which can be economically applied is far below the needs of the soil as shown by its chemical composition.

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[a] Alabama College Sta. Buls. 3, n. ser.; 16, n. ser.; 59, 75, 88.

[b] Alabama Canebrake Sta. Bul. 21.

[c] Mississippi Sta. Rpt. 1895, p. 25.

[d] Louisiana State Sta. Bul. 29, n. ser.

[e] North Louisiana Sta. Bul. 16, n. ser.

[f] Texas Sta. Bul. 45; Rpt. 1889, p. 11.

[g] Tennessee Sta. Bul., vol. 17, No. 2.

[h] Kentucky Sta. Buls. 53, 55.

[i] Ohio Sta. Bul. 124.

At the Indiana Station[a] horse manure applied in 1883 and 1884 increased the yield every year thereafter up to and including 1899, while commercial fertilizers were not profitable. In experiments with different systems of cropping conducted for a series of years[b] commercial fertilizers did not have much effect on the yield of corn, and barnyard manure gave much better results. Where corn had been grown continuously for ten years the results from commercial fertilizers and barnyard manure were about the same. At the Missouri Station[c] solid and liquid barnyard manure applied together increased the yield, horse manure being more effective than cattle manure. Wool ashes gave good results, but neither salt, lime, nor plaster gave an increase. On muck soils in Michigan[d] sulphate of potash proved especially valuable.

The Pennsylvania Station[e] conducted experiments with commercial fertilizers and barnyard manure for a period of twenty years. In the test with the plant-food elements used singly, phosphoric acid, potash, and nitrogen ranked in the order mentioned in the production of grain; while in the yield of stover potash stood first and phosphoric acid second. Where the three essential elements were given in combinations of two they ranked as follows: Potash and phosphoric acid, phosphoric acid and nitrogen, and potash and nitrogen in the production of grain; and potash and phosphoric acid, potash and nitrogen, and phosphoric acid and nitrogen in the production of stover. Dried blood was more effective than nitrate of soda. The use of 48 pounds of nitrogen in the form of sulphate of ammonia in a complete application gave the best results. The use of 12,000 pounds of barnyard manure per acre gave better yields of grain than a larger application, while a better yield of stover was obtained from the use of 20,000 pounds than from the use of a smaller quantity. The use of lime, either alone or with barnyard manure, did not seem beneficial. Corn removed the largest quantity of nitrogen from the soil, followed by hay, wheat, and oats in the order given. With respect to the quantity of phosphoric acid and potash removed, the crops stood in the following order: Corn, hay, oats, and wheat.

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[a] Indiana Sta. Bul. 77; Rpt. 1899, p. 45.

[b] Indiana Sta. Bul. 88.

[c] Missouri Sta. Buls. 14, 32.

[d] Michigan Sta. Rpt. 1895, p. 116.

[e] Pennsylvania Sta. Rpt. 1902, p. 191.

At the Alabama Station[a] the entire growth of vetch, the stubble of vetch, or the entire growth of nearly matured rye or the stubble of rye, was plowed under as a green manuring for corn, and the yield obtained was at least 50 per cent and in some instances 100 per cent greater on the plats where vetch or vetch stubble had been plowed in than on the plats where rye had been grown. There was but little difference in the yield of grain whether the entire vetch plant or only the stubble and roots were plowed under. The yield of silage corn was 2.75 tons less per acre on the vetch stubble plat than on the plat which received the vines, stubble, and roots as a manuring; but this loss in silage corn was more than offset by the yield of vetch hay. The Massachusetts Station[b] found that white mustard sown in corn in July and plowed in in the fall increased the yield of corn the next year by 452 pounds of stover and 5.4 bushels of grain per acre over plats receiving no green manure. At the Iowa Station[c] the results for two years indicated that green manuring for corn with rye or clover is unprofitable at the station.

## PLANTING.

The different experiments conducted by the stations in connection with planting corn consists principally of studies on the time, thickness, and depth of planting, including observations on the distance between the rows and between the hills or stalks in the row. Numerous experiments on the time of planting have been made, and while it is influenced to some extent by the latitude, it will be noticed by the results obtained that the best returns were secured from plantings made in May. Work of this kind was carried on by the Illinois Station[d] for a series of years, beginning in 1888. Weekly plantings beginning in April were made for seven or eight weeks. In 1890 the first planting was made April 28 and the last June 9. The average yield of the corn planted in May was 73 bushels per acre, and the average yield of the three remaining plantings, one in April and two in June, was 63 bushels per acre. The percentage of water in the shelled corn increased in general from the earliest to the latest plantings, being nearly twice as great in the corn planted June 2 as in that planted April 28, and nearly 25 pounds more ear corn to produce a bushel of air-dry shelled corn was required for the latest than for the earliest plantings. These data, in the opinion of the station, indicate that it is a safe practice for the particular locality to plant a medium-maturing variety of corn from about May 5 to 25. It was observed that late plantings do not always require as much cultivation as early plantings. In 1891 little difference was found in the yield of a medium-maturing variety of corn planted at weekly intervals from April 25 to May 23. When planted later the yields were smaller and the ears not so well filled out and not thoroughly matured. In 1893 the largest yield was obtained from planting May 13, followed by one planted May 6. In 1894 Burr White corn was planted at intervals of a week from April 6 to June 22. The average yield for seven years was greatest for planting from May 11 to 18, but the variation in yield was not very marked for the dates between April 22 and May 25. The results of experiments in early and late planting at the Indiana Station[a] during periods of four, five, six, and seven years indicated that the best returns are to be obtained by planting between May 1 and 10. The average results of planting at different dates were as follows: May 1, 40.97 bushels per acre; May 8 to 11, 40.39 bushels; May 15 to 16, 29.82 bushels; May 21 to 22, 37.25 bushels, and May 28 to 30, 31.67 bushels. In 1893 corn planted May 6 matured in 122 days, while corn planted at about weekly intervals until June 16 decreased in the length of its growing period as the date of planting was later. Corn planted on June 16 required only 107 days to ripen. At the Ohio Station,[b] where similar experiments were carried on for a series of years, the largest yield was obtained from a planting made as late as June 4, which goes to show that other factors may entirely obliterate the influence of the date of planting. The average results, however, favored planting not later than May 25. The results of three years' experiments at the South Dakota Station[c] indicated that the best time for planting in that locality was between May 10 and 20. In 1901 the North Dakota Station[d] planted two plats of corn each week from May 18 to July 2. The late planting resulted in a greater yield of stalks and a smaller yield of ears than the early planting. The following year,[e] when the time of planting ranged from May 30 to June 23, the largest yield of fodder was produced from the earliest planting. In 1898 the Oklahoma Station[f] reported that in general the best results of a planting experiment were obtained from plantings made March 28. Corn planted May 1 in ordinary upland soil by the Alabama Station[g] yielded nearly 30 bushels per acre, while a number of varieties planted July 13 on good soil proved complete failures.

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[a] Alabama College Sta. Bul. 105.

[b] Massachusetts Sta. Rpt. 1895, p. 177; 1896, p. 16.

[c] Iowa Sta. Bul. 19.

[d] Illinois Sta. Buls. 4, 13, 31, 37.

The experiments in planting at different depths have shown considerable variation in the results. Such experiments conducted during three successive years at the Illinois Station[h] were in favor of shallow planting. Corn was planted 1, 2, 3, 4, 5, and 6 inches deep.

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[a] Indiana Sta. Buls. 39, 50, 55, 64, 77.

[b] Ohio Sta. Bul., Vol. III, No. 3.

[c] South Dakota Sta. Bul. 24.

[d] North Dakota Sta. Bul. 51.

[e] North Dakota Sta. Rpt. 1902, p. 113.

[f] Oklahoma Sta. Bul. 36.

[g] Alabama College Sta. Bul. 111.

[h] Illinois Sta. Buls. 4, 8, 13, 31.

In two of the seasons the shallow-planted corn came up first, while in one season the deep-planted rows started to grow quicker but were overtaken in growth in four weeks by the shallow-planted rows. There was no direct relation between the depth of planting and the yield in any one season. The first whorl of roots, disregarding those directly at the seed, started at from 1 to 2 inches from the surface whether the kernels were planted shallow or deep. While the results varied considerably, it was found that, in general, where the temperature, moisture, and mechanical condition of the seed bed at planting time were all favorable to the early growth of corn the depth of planting between 1 and 4 inches made but little difference. Summarizing the results of five years of this work, it is shown that the yield was decreased as the depth of planting increased. In similar experiments conducted at the Ohio Station[a] from 1883 to 1889, although showing considerable variation, the average yield of grain was in favor of planting only 1 inch deep, and the results of single seasons showed plainly that shallow planting was best, except in continued dry weather. Through the series of years both the yields of grain and fodder were sometimes in favor of shallow and sometimes in favor of deep planting, and these differences are considered due to other causes than the variation in the depth of planting. At the North Dakota Station[b] planting from 2 to 4 inches deep has given the best results.

The work with planting corn at different distances has apparently been more general than any other line of investigation with the crop. The Illinois Station[c] found that with the same rate of planting more stalks were produced where one kernel was planted in the hill, while planting two, three, and four kernels to a hill showed but very little difference. There was a somewhat regular though not constant increase from the thickest to the thinnest planting in the weight of stalks and ears. The average weight of 100 stalks of stover—that is, stalks with the ears removed—varied from 40 pounds in the thickest planting to 97 pounds in the thinnest planting, while the weight of 100 ears ranged from 23 pounds to 70 pounds. The development of the plants seemed to have depended mostly upon the thickness of planting and but little upon the method of distribution. Better development was obtained, however, where two or three kernels were planted in a hill than where one or four kernels were planted. The number of ears varied from 18,932 on the thickest-planted plat to 5,664 on the thinnest-planted one. Taking an average of the first four plantings, the number of ears produced per acre with one kernel to a hill was 13,529; with two kernels, 12,504; with three kernels,

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[a] Ohio Sta. Rpt. 1888, p. 77; Bul., Vol. III, No. 3.

[b] North Dakota Sta. Bul. 51; Rpt. 1902, p. 113.

[c] Illinois Sta. Bul. 4.

12,216; and with four kernels, 12,649. Where two and three kernels were planted the ears were a little larger than where but one was planted. The number of ears from the different plantings represented yields of 92.8, 93.4, 87.4, and 87.8 bushels per acre, respectively. Planting two kernels in a hill produced the largest number of good ears. In another series of experiments[a] carried on for three years corn was planted at the rate of 47,520, 23,760, 15,840, 11,880, 9,504, and 5,940 kernels per acre. The first year the number of stalks harvested where one kernel was planted was somewhat greater than where two, three, or four kernels were planted to a hill, but the second year there was substantially no difference in the ratio of stalks harvested to kernels planted. While the number of ears increased by thicker planting, the proportion of barren stalks and nubbins also increased. In both seasons planting at the rate of one kernel every 6 inches gave better results than one kernel every 3 inches, if the crop was grown for fodder; and planting one kernel every 9 or 12 inches gave the best results if the crop was grown for the grain. In general, the results of the two years indicated that the quantity of seed planted controlled the yield, rather than planting one, two, or four kernels in a place. The third year it was observed that, in general, the stalks stooled where the planting was at a rate of less than one kernel for every foot. On the plat planted at the rate of one kernel every foot about as many stalks were harvested as kernels were planted, while where the planting was thicker fewer stalks were harvested than kernels planted. The average for three years shows that nearly three times as many ears were harvested from the thickest than from the thinnest plantings. The average yield of corn and stalks decreased constantly from the thickest to the thinnest plantings. The thickness of planting represented by one kernel every 12 inches, two kernels every 24 inches, and so on, gave the largest average yield of shelled corn per acre for the three years; and this thickness of planting also gave the largest yield of shelled corn from good ears for every season of the experiment. With the same rate of planting the average results showed no material difference in the yield when one or more kernels were planted per hill. The station[b] also made a comparison of planting in rows 3 feet 8 inches apart, with single kernels 3, 6, and 9 inches distant, and three kernels every 9, 18, and 27 inches, being in both cases at the rate of 47,520, 23,760, and 15,840 kernels per acre. The weight of the ears and stalks, the number of ears, and bushels of corn per acre were greatest for the thinnest plantings and least for the thickest plantings. Corresponding results had been secured during each of the three preceding years. In a second experiment with hills at different distances and with different numbers of kernels per hill the results showed that, in general, the ratio of stalks grown to kernels planted and weight of ears decreases as the rate of thickness in planting increases, while the percentage of barren stalks also increases. From the results of all trials[a] it is concluded that in average seasons in central Illinois three stalks in the hill will produce better results than thicker planting. In 1894 the station[b] planted two, three, four, and five kernels in hills 3 feet 8 inches apart each way, and obtained from planting two kernels 40.2 bushels, from three kernels 46 bushels, from four kernels 49 bushels, and from five kernels 48 bushels per acre; and in another test three kernels per hill yielded 44.6 and five kernels per hill 50.5 bushels per acre. The thicker plantings produced a greater proportion of nubbins. With maximum yields there were generally about 10,000 ears per acre.

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[a] Illinois Sta. Buls. 8, 13.

[b] Illinois Sta. Bul. 20.

The Kansas Experiment Station[c] determined the yield of corn rows having an irregular stand in which the distance between plants averaged from 12 to 24 inches. It was found that the yield where the stalks averaged 24 inches apart was 29.7 bushels per acre, and that the yield increased with the number of stalks in the row until the distance between them averaged 15 inches, where the yield was 58 bushels. The yield then declined to 45.1 bushels per acre, with stalks averaging 12 inches apart. The variety of corn grown in these tests was a medium large dent, and the largest yield was obtained when the kernels were planted 14 to 16 inches apart in the row. Deviations from this distance, as is shown by the results, were promptly followed by a decrease in yield. In another experiment[d] a medium-sized yellow dent corn was grown on a clay loam upland soil of moderate fertility in rows 2½, 3, and 3½ feet apart, with the difference between the stalks in the row varying from 4 to 16 inches. The rows 3½ feet apart, with the stalks 4 inches distant, gave the highest yield, being 73 bushels of corn and 3 tons of fodder per acre, but only 14½ per cent of the corn was merchantable. The largest yield of corn, 73.77 bushels per acre, was obtained from the planting made in rows 3½ feet apart, with an interval of 12 inches between the plants; 58 per cent of the ears from this planting was marketable corn. The highest yield of fodder, 3.93 tons, came from the rows 2½ feet apart, with the stalks at distances of 4 inches. The yield of fodder from the rows with stalks 4 inches apart was more than double the yield where the stalks were 12 or 16 inches apart, and its value for feed was more than twice that of the fodder from the wider planting. It is pointed out that thick planting decreases the rank growth of stalks and increases the value of the fodder by increasing the proportion of leaves and grain, and that it produces small ears which are easily eaten by cattle without being broken, crushed, or ground. The different distances in planting for grain and fodder were also tested.[a] The corn was surface-planted and listed in rows from 1.5 to 4 feet apart, and the distance between stalks from 4 to 20 inches. Three varieties were grown—St. Charles, white and late-maturing; Leaming, yellow and medium maturing; and Pride of the North, yellow and early maturing. From the results it was found that small to medium sorts, like Pride of the North, are best planted in rows 3 feet apart, with the plants 16 inches apart in the row. The yield of merchantable corn, however, was highest in rows 3½ feet apart and the plants 20 inches apart in the row. St. Charles gave the best yield of merchantable corn in rows 3 feet apart, with 20 inches between plants. On the listed plats the best yields were obtained in the rows 4 feet apart, with the stalks 8, 12, and 16 inches apart, for Pride of the North, Leaming, and St. Charles, respectively; but the best yield of salable ears was obtained when the stalks were 4 inches farther apart in each case. The highest weight of fodder was obtained from planting 4 inches apart in the row.

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[a] Illinois Sta. Bul. 31.

[b] Illinois Sta. Buls. 37, 42.

[c] Kansas Sta. Rpt. 1888, p. 15.

[d] Kansas Sta. Rpt. 1889, p. 19.

The average results for two seasons at the Missouri Station[b] show no difference in the yield from planting 3 feet 9 inches apart each way, with two, three, or four grains in a hill. In field experiments[c] conducted for three years the total yield from rows 45 inches apart, with intervals of 45 inches between the hills, increased as the number of stalks in the hill increased, but there was also an increased proportion of unmerchantable ears. A single season's trial in this connection indicated that with a stand of 85 per cent it was unprofitable to replant the missing hills. Experiments at the Indiana Station[d] suggested that corn to be grown for silage may be dropped 6 or 8 inches apart, and corn for grain, 12 or 14 inches apart, in the drill. The average results for eight years[e] with rows 3⅔ feet apart were as follows: Stalks 10¾ inches apart, 50.71 bushels per acre; stalks 12⅛ inches, 49.30 bushels; stalks 13¾ inches, 50.08 bushels; stalks 16¼ inches, 46.22 bushels; and stalks 19½ inches, 43.38 bushels per acre. In 1893, contrary to the results in previous years, every increase in distance was followed by an increase in yield. During the dry season of 1893–94[f] every increase in the distance between plants from 11 to 19½ inches was followed by an increase in yield. However, taking the average results for nine years, distances 11, 12, and 14 inches between stalks produced larger yields of grain than thinner planting, but the largest yield of stover in both favorable and unfavorable seasons was from thick plantings. Later results obtained at the station[g] show that the greatest average yields of ears and stalks were obtained when single stalks stood 12 to 14 inches apart in rows 3½ feet distant. Thick planting reduced the size of the ears and the percentage of grain, but in dry seasons it produced the heaviest yield of stalks.

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[a] Kansas Sta. Bul. 30.

[b] Missouri Sta. Bul. 14.

[c] Missouri Sta. Bul. 32.

[d] Indiana Sta. Bul. 43.

[e] Indiana Sta. Bul. 50.

[f] Indiana Sta. Bul. 55.

[g] Indiana Sta. Bul. 77.

The results of a series of experiments at the Ohio Station[a] show that planting single kernels 6 inches apart increases the yield of fodder and the percentage of nubbins. With this thickness of planting, the average of full-sized ears was reduced by nearly one-half. The average yield was fully as high where the stalks stood 12 inches apart in the row, and the large ears constituted more than four-fifths of the entire yield, while a distance of 18 inches reduced the total yield of grain by about 14 bushels per acre without materially reducing the number of large ears. The maximum yield of nubbins, amounting to 70 per cent, was obtained where two grains were planted every 6 inches. In another experiment[b] kernels were planted from 9 to 49 inches apart in the row and from one to four grains in the hill. The average yields for three years were, with kernels 12 inches apart, 79.7 bushels per acre; kernels 15 inches apart, 64.9 bushels; and kernels 18 inches apart, 64.4 bushels. From planting 6 inches apart, in 1888 and 1889, an average yield of 101.9 bushels per acre was obtained, but 47 per cent of the ears were nubbins. In a three-year experiment the results indicated[c] that planting one grain every 12 inches and two every 24 inches was better than planting three every 36 inches and four every 42 or 48 inches in rows about 3½ feet apart. Growing one stalk every 18 inches gave the highest percentage of sound corn, but with a reduced total yield.

The Vermont Station[d] planted corn in rows 3 feet apart and the kernels 36, 24, 12, and 6 inches in the row. The highest yields were obtained from the widest and the narrowest plantings. The total yield of the 6-inch planting was more than that from the 36-inch planting, but the yield of ear corn was largely in favor of the greater distance. The Connecticut Station[e] in 1888 planted, in rows 4 feet apart, one kernel to every 4 feet, one to every 2, and one, two, four, and eight to every 1 foot. White Edge Dent and Rhode Island White Capped Flint entered into the experiment. The flint corn produced the most dry matter when the plants stood a foot apart in the row, and the dent variety when the plants stood two to a foot in the row. With the flint variety the yield of sound kernels on dried shelled corn increased steadily with the thickness of planting up to a stand of two plants to the foot, after which the yield declined rapidly, and where eight plants per foot were grown no sound kernels were produced. The dry weight of leaves increased regularly with the thickness of planting and the dry weight of stripped stalks up to a stand of one plant to a foot. The water-free weight of stripped stalks of the flint corn was greatest where the plants stood one to a foot in the row, while in the case of the dent variety this weight increased steadily with the thickness of stand and was greatest where eight plants were grown per foot of row. The proportion of sound kernels of the flint variety to the total water-free crop increased with the thickness of planting up to a stand of two stalks to the foot, decreasing rapidly with closer planting, while the proportion of kernels of the dent corn to total crop was greatest where one stalk was grown each 2 feet. The proportion of leaves to total dry crop was largest where the proportion of sound kernels was lowest, and the proportion of yield of stripped stalks was, in general, largest where the stand was thickest. The proportion of dry weight of stalks of the dent variety showed a regular increase from the plat with the stalks 2 feet apart up to the thickest stand. The individual plants attained their greatest development in all their parts where they stood farthest apart and, consequently, had the most light and the most soil at their disposal, and the yield per plant decreased quite regularly as the stand became thicker, although not proportionally to the closeness of the stand. At the Maine Station[a] the largest yield of both green crop and dry matter was obtained from planting kernels 9 inches apart. The distance of planting had apparently no effect on the composition of the grain. The best ears were produced by the corn planted 9 and 12 inches apart. The average yield per acre of dry matter at this station[b] for three seasons at different rates of seeding was as follows: Kernels 6 inches apart, 5,699 pounds; at 9 inches, 5,827 pounds, and at 12 inches, 5,432 pounds.

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[a] Ohio Sta. Rpt. 1888, p. 83.

[b] Ohio Sta. Bul., Vol. IV. No. 1.

[c] Ohio Sta. Bul. 78.

[d] Vermont Sta. Rpt. 1888, p. 95.

[e] Connecticut State Sta. Rpt. 1889, p. 220.

The Louisiana Stations[c] obtained the best results with rows 5 feet apart. Thinning to one and two stalks per hill yielded 42 and 44 bushels per acre, respectively. In another series of tests[d] the best yields in 4-foot rows were obtained where two stalks grew every 2 feet of row and in 5-foot rows where two stalks stood every 18 inches. Results obtained at the Alabama Station[e] during a dry season show that the yields were practically the same whether the distance between single plants in rows 5 feet apart was 3 or 5 feet, and that a distance of 2 feet in the row greatly reduced the yield. Later results[f] showed that where each plant was allowed 15 square feet of space narrow rows and wide spacing in the drill gave slightly better average results than wide rows and close planting in the drill. On poor, sandy soil rows about 5 feet apart, with plants 3 feet apart in the drill, gave most satisfactory results. In a series of experiments conducted in 1896 and 1897, the results of both seasons favored planting so that the distance in the drill nearly equals the distance between the rows.[a] The Georgia Station[b] concludes from its work that a distance of 2 by 4 feet is preferable to other distances on upland soils capable of producing from 35 to 40 bushels of corn per acre, but that on the unimproved and badly worn soils the distance between hills should range from 5 by 4 feet to 5 by 5 feet. At the Tennessee Station[c] Hickory King and Cocke Prolific were planted in hills of two stalks each at distances of 30, 36, 42, 48, 54, and 60 inches. The average results for three years with Hickory King were as follows: Thirty inches, 48.93 bushels; 36 inches, 45.15 bushels; 42 inches, 42.49 bushels; 48 inches, 42.52 bushels; 54 inches, 37.44 bushels, and 60 inches, 32.56 bushels. The results with the other variety were similar. At 30 inches the yield was largest, but the ears were small and deformed, while at 40 inches the form of the grain and the quality of the ear was good. The station calls attention to the fact that these results indicate that 100 acres of Hickory King planted at 48 inches would have yielded 500 bushels more grain than if planted at 54 inches, and 1,000 bushels more than if planted at 60 inches.

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[a] Maine Sta. Rpts 1894, p. 37; 1895, p. 19.

[b] Maine Sta. Rpt. 1896, p. 30.

[c] Louisiana Stas. Bul. 7, 2d ser.

[d] Louisiana Stas. Bul. 22, 2d ser.

[e] Alabama College Sta. Bul. 75.

[f] Alabama College Sta. Bul. 88.

Corn planted at different rates at the Pennsylvania Station[d] resulted in the best development of stalk and ear when planted at the rate of one kernel every 12 inches, or 12,445 kernels per acre, producing on the average one stalk every 15 inches, or 9,600 stalks per acre. The largest yield, 69 bushels per acre, was obtained where one kernel was planted every 6 inches in rows 42 inches apart. In this case there were 19,660 stalks produced per acre, or one stalk every 7½ inches in the row. There were four thicknesses of planting at the rate of one kernel every 3, 6, 9, and 12 inches, and four methods of distribution, namely, one, two, three, and four kernels per hill. The distribution was apparently without effect. Where the corn was planted every 3 instead of 6 inches, the weight of ears was 1,850 pounds, or 23 bushels less from the former than from the latter; but this decrease in the yield of corn was replaced by 2,500 pounds of stover.

More recent experiments in thickness of planting at the North

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[a] Alabama College Sta. Bul. 111.

[b] Georgia Sta. Buls. 10, 34, 37, 46, 51.

[c] Tennessee Sta. Bul., Vol. XVII, No. 2.

[d] Pennsylvania Sta. Rpt. 1891, p. 54.

Dakota Station[a] showed the largest yield of fodder from corn planted in rows 22 inches apart. Drilled corn produced more fodder than corn planted in hills in rows 44 inches apart, but the largest yield of ears was obtained from planting in hills. Corn sown broadcast did not yield as well as corn sown in drills. Drilling corn 6 inches apart in rows 3½ feet apart gave the best average total yield for two years, the yield decreasing almost regularly with a decrease in the distance between the plants in the row. Planting six kernels in a hill gave a larger yield of fodder and ears than planting a smaller number of kernels. In 1901 this same station obtained on the average 1 ton 620 pounds of dry fodder more per acre from corn drilled in rows 6 inches apart than from those 42 inches apart. The results of other experiments[b] were also in favor of 6-inch drills for different dates of planting. In another test the best yield of fodder was obtained from 12-inch drills followed by planting in hills in rows 22 inches apart. Earlier results with planting in drills, however, have indicated that for the production of ears the drills should be 36 and 42 inches distant. Experiments on the thickness of planting in drill rows with one kernel every 6 inches in the drill gave the best yield of fodder in 1902, and also the largest average yield for three seasons. In growing corn for fodder in hills six stalks in a hill gave the largest average yield for three trials.

The work of the Iowa Station[c] points out the importance of planting a uniform number of kernels, and recommends that the planter used should drop ninety-three to ninety-six times out of a hundred the number of kernels desired. When uniform-sized kernels were used the planter in one test dropped two kernels eight times and three kernels ninety-two times out of a hundred. With kernels irregular in size the number of times one, two, and four kernels were dropped per hundred was largely increased.

Comparative tests of hill and drill planting have also been carried on by a number of the stations. These experiments are, in a measure, studies on the thickness of planting. At the Illinois Station[d] one plat was planted in drills and two similar ones in hills. One of the plats planted in hills was cultivated both ways, the other one way. The yield of shelled corn per acre was 60.8 bushels on the plat planted in drills, 71.7 on the plat planted in hills and cultivated one way, and 77.7 on the plat cultivated both ways. Repeated trials at this same station[e] have shown that under like conditions there is no perceptible difference in the average yield whether the corn is planted in hills or drills, the number of stalks secured being a greater factor than their mode of distribution. In many cases it is more difficult to keep drilled corn free from weeds. "In no year out of the six was any material difference shown in the yield of corn, whether planted in hills or drills, where equal numbers of kernels were planted."[a] The Kansas Station[b] made a comparison of listed corn in hills and drills and surface-planted corn in drills and check rows. The number of plants grown in every row was made the same throughout the entire experiment. The drilled plats contained one plant to every 16 inches of row, and the hilled plats contained usually the same number of plants. The listed drills yielded 6.07 bushels of corn and 0.28 ton of fodder per acre more than the surface drills, and the listed hills 5.52 bushels of corn and 0.49 ton of fodder more than the surface check-rowed plats. During a wet season[c] listed corn yielded 3½ bushels, or 4 per cent, more per acre than a surface-planted crop, while in the dry season of the previous year the results of a similar experiment favored listing by nearly 15 per cent. It is pointed out that listed corn can be planted with less time and labor, withstands drought and winds better, and requires less cultivation. At the Nebraska Station[d] corn planted in rows both ways yielded 30 bushels per acre and listed corn yielded 18 bushels, while on light soil in the western part of the State listed corn yielded 40 bushels per acre and corn grown by the other method 38 bushels. The North Dakota Station[e] obtained the largest yields of fodder from corn planted in hills in rows 22 inches apart, while drilled corn produced more fodder than corn planted in hills in rows 44 inches apart; but the largest yield of ears was obtained from planting in hills. At this same station[f] 12-inch drills gave the best yield of fodder, followed by planting in hills in rows 22 inches apart. Former results with planting in drills have indicated that for the production of ears the drills should be 36 or 42 inches distant. Planting one kernel every 6 inches in the drill gave the best yield of fodder in 1902 and also the largest average yield for three seasons. Five stalks in the hill gave the largest yield of fodder for this season and six stalks in the hill the largest average yield for three trials.

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[a] North Dakota Sta. Bul. 51.

[b] North Dakota Sta. Rpt. 1902, p. 114.

[c] Iowa Sta. Bul. 68.

[d] Illinois Sta. Bul. 13.

[e] Illinois Sta. Bul. 25.

Corn at the Massachusetts Station[g] planted in 3½-foot rows in hills containing three plants each at a distance of 3 feet in the row, and in drills with single plants 1 foot apart in the row, gave the more valuable total crop from the drill system of planting. In 1895 and

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[a] Illinois Sta. Bul. 31.

[b] Kansas Sta. Rpt. 1888, p. 52.

[c] Kansas Sta. Rpt. 1889, pp. 19, 20.

[d] Nebraska Sta. Bul. 54.

[e] North Dakota Sta. Bul. 51.

[f] North Dakota Rpt. 1902, p. 114.

[g] Massachusetts Sta. Rpt. 1895, p. 196.

1896 at the New York Cornell Station[a] broadcasting gave the largest total yield of forage as compared with corn grown in hills and drills, but the feeding value of the product was lower. Results with King Philip corn at the New York State Station[b] were in favor of planting in hills, followed by planting in drills and broadcasting in the order mentioned. At the Maryland Station[c] corn drilled in rows 3 feet 9 inches apart and 22½ inches distant in the row has given increased yields each year of the test over corn planted in hills 3 feet 9 inches distant each way and two stalks in the hill. A comparison of drill and hill planting at the Ohio Station[d] covering a period of four years shows that planting one grain every 12 inches in the row gave the best yield, but planting two grains every 24 inches gave practically the same results. In a comparison of drilling and broadcasting corn for silage the Mississippi Station[e] obtained 2,925 pounds more per acre by drilling than by broadcasting. The result represented a net financial advantage of $3.35 per acre.

### CULTIVATION.

Numerous experiments in the frequency and depth of cultivation have been made by the experiment stations since their establishment, and the results have thrown much light upon the subject, effecting in many localities a change in the method of cultivating the crop. Some of the earliest work done by the stations was along this line. In 1888 and 1889 good yields were obtained at the Illinois Station,[f] when no cultivation was given except the removal of the weeds by scraping the surface of the soil. There was practically no difference in the yield whether corn was cultivated four, six, or twelve times, the only benefit from the extra cultivation being that the land was kept much freer from weeds. Shallow cultivation gave better results than deep cultivation, but the weeds were much more effectually destroyed by the deep tillage. The results for several years[g] indicated that any cultivation of the soil which effectually removes the weeds with little or no disturbance to the roots is of the greatest benefit. For four years[h] shallow cultivation gave an average yield of 75.9 bushels, as compared with 70.8 and 72.9 bushels from simply scraping the weeds from the surface; and taking the average of five years[i] shallow cultivation produced 5.9, and scraping the surface 2.7 bushels more per acre than deep cultivation. During a season of ideal moisture conditions[j] very little difference was shown in the yields from a plat from which the weeds were removed without cultivation, one mulched with grass 6 inches deep after the first cultivation, another cultivated deeply with a double-shovel plow, and several others cultivated 6 inches deep with a harrow-toothed cultivator.

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[a] New York Cornell Sta. Bul. 135.

[b] New York State Sta. Rpt. 1889, p. 260.

[c] Maryland Sta. Buls. 33, 62.

[d] Ohio Sta. Bul. 140.

[e] Mississippi Sta. Rpt. 1888, p. 30.

[f] Illinois Sta. Bul. 4.

[g] Illinois Sta. Bul. 13.

[h] Illinois Sta. Bul. 20.

[i] Illinois Sta. Bul. 31.

[j] Illinois Sta. Bul. 46.

At the Indiana Station[a] cultivating from 1 to 1½ inches deep gave the largest yields, with only about one-half the labor. The average yields for nine years[b] were in favor of shallow cultivation, with but little difference in the yields from cultivating 1 and 2 inches deep. This station[c] also conducted an experiment in restoring humus on a soil which had produced corn for ten successive years. The methods of restoring the humus consisted in (1) passing the corn stover through a feed cutter and returning it to the soil at the time of plowing, (2) applying wheat straw equal in weight to the stover produced, and (3) sowing crimson clover in the fall to be turned under the following spring. Judging from the resulting yields, the first method was far superior to the other two. During the ordinary season of 1888 the Ohio Station[d] obtained the lowest average yield from the largest number of cultivations, while in the dry season of 1889 the corresponding plats gave the highest average yield. Experiments in deep and shallow cultivation were carried on by this station[e] for nine years. Deep cultivation consisted in working the soil with a shovel cultivator to a depth of 4 inches and shallow cultivation in stirring the soil with a spring-tooth cultivator to a depth of 1½ inches. The average results for the nine seasons show that the shallow-cultivated plats yielded 4 bushels of grain and 213 pounds of stover more per acre than the plats receiving deep cultivation. At the Pennsylvania Station[f] corn on a compact clay not stirred after planting yielded 47 bushels per acre, as compared with 58 and 59 bushels where the cultivation was 2 and 4 inches deep, respectively. Frequent cultivation and cultivating after the usual time of laying corn by did not prove beneficial.

The average yield for two seasons at the Missouri Station[g] from a series of plats showed an increase of 25.2 per cent in favor of shallow tillage as compared with deep tillage. In these experiments a plat from which the weeds were removed with a sharp hoe without stirring the soil yielded more than the deep-tilled plats and less than the shallow tilled. Weekly determinations of soil moisture for eleven weeks, ending August 6, showed that the shallow-tilled plats contained more moisture than either the deep-tilled plats or the plats receiving no tillage. No relation was observed between the amount of cultivation and the yield as long as the weeds were kept down.

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[a] Indiana Sta. Rpt. 1891, p. 350.

[b] Indiana Sta. Rpt. 1897, p. 51.

[c] Indiana Sta. Rpt. 1901, p. 22.

[d] Ohio Sta. Bul., Vol. III, No. 3.

[e] Ohio Sta. Bul. 140.

[f] Pennsylvania Sta. Rpt. 1891, p. 51.

[g] Missouri Sta. Bul. 14.

A comparison of tilling one way continuously and cross plowing once was in favor of cross cultivation. In ordinary seasons different methods of cultivation at the Kansas Station[a] did not give materially different results, and the conclusion is reached that on good soil in an ordinary season cultivation to keep the ground free from weeds is adequate, but that a greater amount of tillage may be profitable in a dry season or on poor soil. Cultivating once in two weeks and four times during a wet season gave the best results on a clay loam soil.[b] Cultivating once a week gave slightly better results during a period of three years than either cultivating twice a week or once in two weeks. The largest average yield for two years was secured from shallow cultivation.[c] Where corn was cultivated from one to six times the average results for three years were in favor of four cultivations.[d] At the Oklahoma Station[e] shallow cultivation resulted in a smaller yield than deep cultivation for drilled corn, but in a larger yield for listed corn. Drilled corn made the largest yield when cultivated deep five times and listed corn when cultivated shallow ten times. In a cultivation experiment at the Utah Station[f] corn was given shallow, medium, deep, and no tillage, and the soil was scarified and mulched with sowed dirt. The test covered five years, and on the whole medium tillage gave slightly the best results. At the Nebraska Station[g] cultivation 3 inches deep gave much better ter results than cultivation about 6 inches deep.

The South Dakota Station[h] found that thorough preparation of the soil before planting and early cultivation before and immediately after the corn is up is most effective in clearing the field of weeds, and that frequent shallow cultivation throughout the first half of the season is most favorable to the development and maturity of the corn. At the North Dakota Station[i] the results of shallow and deep cultivation were generally in favor of shallow cultivation. Shallow tillage early in the season and deep tillage late in the season gave better results than continuous deep cultivation or deep cultivation early followed by shallow cultivation later on. Harrowing the corn immediately after planting proved a very effectual means of destroying young weeds.

Late and deep cultivation at the Iowa Station[j] somewhat reduced the yield. The average results for two years[k] show yields of 71.9 bushels with deep cultivation and 82.4 bushels with shallow cultivation. In a series of experiments during four consecutive years at the Wisconsin Station[a] corn cultivated 3 inches deep gave better yields than that cultivated 1½ inches deep. The deeper cultivation also left the soil more moist below the stirred surface soil, but the higher soil temperatures were in favor of the land receiving shallow cultivation. Certain plats at the New Hampshire Station[b] were given no cultivation, others five, and others fourteen cultivations. Some of the plats were cultivated deep and others shallow. On the plats not cultivated the weeds grew luxuriantly and the yield was reduced to 17.1 bushels of shelled corn per acre. The plats cultivated shallow fourteen times yielded at the rate of 80.6 bushels of shelled corn per acre; cultivated shallow five times the yield was 79.1 bushels, and cultivated deep five times, 69.7 bushels per acre. The amount of stover yielded in each instance stood in about the same ratio as the grain production.

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[a] Kansas Sta. Rpt. 1889, pp. 19, 20.
[b] Kansas Sta. Bul. 30.
[c] Kansas Sta. Bul. 45.
[d] Kansas Sta. Bul. 64.
[e] Oklahoma Sta. Bul. 10.
[f] Utah Sta. Bul. 66.
[g] Nebraska Sta. Bul. 54.
[h] South Dakota Sta. Rpt. 1890, p. 113.
[i] North Dakota Sta. Bul. 51.
[j] Iowa Sta. Bul. 19.
[k] Iowa Sta. Bul. 55.

Plats receiving shallow cultivation at the Georgia Station[c] averaged 2.4 bushels of shelled corn per acre more and 38 pounds of cured fodder less than those receiving deep culture. In another tillage test,[d] cultivating thrice in succession every three weeks, twice every two weeks, and once every week resulted in yields of 32.65, 31.25, and 32.55 bushels of shelled corn, respectively. The results of later work along this same line[e] indicated that cultivation once a week for corn on unfertilized land is better than less frequent but more thorough working of the soil, while on well-fertilized land the more thorough tillage at longer intervals is the most advantageous. The results of cultivation experiments at the Alabama Station[f] indicate that the first cultivation should be deep and that frequent cultivation should be continued late into the season. At the South Carolina Station[g] corn planted on the level without cultivation, except the cutting out of grass and weeds with the hoe, gave practically as good yields as corn planted in furrows and cultivated shallow the first time and deep afterwards. The Mississippi Station[h] examined the records of one hundred and sixteen tests of shallow and deep culture made at different stations and found that sixty-one tests of deep cultivation gave an average yield of 64.9 bushels per acre, while fifty-five tests of shallow cultivation gave an average of 74.7 bushels, a difference of 9.8 bushels per acre, or more than 15 per cent in favor of shallow cultivation.

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[a] Wisconsin Sta. Rpt. 1894, p. 266.

[b] New Hampshire Sta. Bul. 71.

[c] Georgia Sta. Bul. 10.

[d] Georgia Sta. Bul. 55.

[e] Georgia Sta. Bul. 62.

[f] Alabama College Sta. Bul. 111.

[g] South Carolina Sta. Bul. 44.

[h] Mississippi Sta. Bul. 33.

## DETASSELING.

The effects of detasseling were studied by the stations several years ago, but recently no further attention has been given to the subject. In over 50 per cent of the experiments reported the results indicated that detasseling had been either injurious or without effect. The most marked results in favor of the practice were obtained in experiments by the New York Cornell Station,[a] the increase in total yield being as follows: In 1890, 50.6 per cent; in 1891, a very small gain; in 1892, 21 per cent, and in 1893, 19.3 per cent. On the other hand, the Nebraska Station[b] obtained 528 pounds of corn from ten detasseled rows, 1,220 pounds from ten normal rows alternated with the detasseled rows, and 2,369 pounds from twenty normal rows elsewhere in the field. At the Kansas Station[c] the results were also decidedly against detasseling. On plats from which the tassels were removed from alternate rows the detasseled rows yielded 114.55 pounds of corn, and the rows with tassels entire, 185.75 pounds. Where only the first tassels were removed and the later appearing ones allowed to develop the yield per plat was 329.57 pounds, and where the tassels were removed from alternate stalks the detasseled stalks yielded 71.77 pounds and the stalks not detasseled 151.61 pounds. Unfavorable weather at a critical period in the growth of the crop caused a scarcity of pollen for the fertilization of the ears, and detasseling made the matter worse. The Illinois Station[d] believes that if detasseling is beneficial at all it is most likely to be so on poor soil or in dry seasons, and that the practice sometimes reduces the yield.

## IRRIGATION.

In connection with a series of investigations in soil physics, begun by King at the Wisconsin Station[e] in 1889 and continued until 1901, the water requirements of corn and the influence of irrigation on the yield were studied. It was found that corn is able to draw upon the permanent water in the ground when it lies at least 7½ feet below the surface in the case of a subsoil of rather coarse sand, and that the crop may reduce the water in a subsoil of sand to 7 per cent of the dry soil at a depth of 40 inches below the surface when the water table is only 42 inches lower. The observation was also made that on May 13 recently planted corn ground contained 23.33 pounds of water to the 100 pounds of dry soil in the surface 6 inches, while clover on the same kind of soil near by had reduced the water content to 8.59 pounds to the 100 pounds of dry soil.

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[a] New York Cornell Sta. Bul. 61.

[b] Nebraska Sta. Bul. 25.

[c] Kansas Sta. Bul. 45.

[d] Illinois Sta. Bul. 37.

[e] Wisconsin Sta. Rpt. 1889, p. 195.

In 1890[a] the water content of soil upon which corn was grown was determined at the time of planting and when the corn was cut to ascertain the weight of water required for a pound of dry matter, as indicated by the diminished soil moisture and the precipitation between planting and harvesting. The results apparently showed that about 414 pounds were required to produce a pound of corn. A similar experiment the following year showed that in one case 309 pounds of water for 1 pound of dry matter had been required on manured ground and 333 pounds on unmanured ground. The difference in results is believed to be probably due to the difference of percolation in the soil during the two seasons. The average quantity of water required to produce a pound of dry matter in 1891 and 1892[b] was 309.2 pounds. In two tests dent corn required an average of 309.84 pounds of water and flint corn in a single experiment 233.9 pounds for the production of 1 pound of dry matter, or, in other terms, the former required 1.8 times and the latter 2.2 times the season's rainfall. In 1894 and 1895[c] surface irrigation and subirrigation of corn were tested, and in all cases the yield from the irrigated land was much larger than from the unirrigated land, and surface irrigation yielded both years much better than subirrigation. In 1896[d] a rainfall of 15.02 inches, from May 1 to August 31, was well distributed through the season, and still the yield on irrigated ground exceeded that on ground not irrigated by about 1 ton per acre. The yield of shelled corn was also in favor of the irrigated ground, the difference being greater for thickly than for thinly planted corn.

In 1897[e] these experiments had been conducted on the same plats without the use of fertilizers for four years. The rainfall during the growing season had ranged from 4.48 inches in 1895 to 15.02 inches in 1896, and the water supply by irrigation from 5.7 inches in 1897 to 26.6 inches in 1895. In every season the yields were increased by irrigation. The largest quantity of feed was obtained from three stalks per hill, at distances of 15 inches, in rows 44 inches apart, when grown with only the natural rainfall, and also when a little more than 7 inches of water in addition was supplied by irrigation. The smallest yields of dry matter were obtained where only one stalk per hill was grown. The yields of shelled corn were largest from thin planting receiving only the natural rainfall, and these yields were nearly as large as where the plats were irrigated, indicating that with a thin stand the rainfall was nearly sufficient for a maximum yield. In determining the cost of irrigation in 1897 it was found that with an ordinary farm engine, using coal at $5 per ton, water was raised 26 feet through a 6-inch pipe at a cost of $17.32 per acre-inch, and with a 2½-horsepower gas engine, using gas costing $1.25 per thousand feet, the cost of raising water 12.85 feet was $15.75 per acre-inch.

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[a] Wisconsin Sta. Rpt. 1891, p. 124.

[b] Wisconsin Sta. Rpt. 1892, p. 94; 1893, p. 152.

[c] Wisconsin Sta. Rpt. 1895, p. 237.

[d] Wisconsin Sta. Rpt. 1896, p. 195.

[e] Wisconsin Sta. Rpt. 1897, p. 222.

After the experiments had been carried on for five years the results indicated that the fertility of the irrigated ground was being perceptibly reduced. The sixth year 37 per cent more dry matter was produced on the irrigated than on the unirrigated plats.[a] In 1900[b] the average yield of water-free substance per acre for the entire period since 1894 was 1,993 pounds greater for irrigated ground than on ground not irrigated. The first four years of the experiment the average gain due to irrigation was 3,543 pounds of water-free substance per acre, but for the last three years it was only 62.2 pounds. In 1901[c] the increase in yield of corn by supplementing the rainfall by irrigation amounted to 4.2 tons of silage, 1.9 pounds of dry matter, and 35.16 bushels of ear corn per acre.

Irrigation in addition to the natural rainfall increased the yield of corn at the Louisiana Stations[d] by 100 per cent. Soil-moisture investigations for the seasons of 1901 and 1902 at the New Mexico Station[e] showed that irrigations made at the time of planting, before tasseling, and when the grain was forming, which is the ordinary Mexican method, will produce a fair crop of corn, but that in the ordinary seasons of that region from one to three additional irrigations will prove beneficial. At the Utah Station[f] the percentage of protein in corn kernels was increased from 12.05 to 15.08, as the amount of irrigation was decreased from 37.26 inches to 7.50 inches. The proportion of ears to stover in these experiments increased regularly with the increased application of water. Late irrigations did not affect the growth and yield of the crop unfavorably. It is estimated that the best amount of water for corn lies between 20 and 25 inches.

### RATE OF GROWTH.

The relation of meteorological conditions to the development of corn was studied by the Pennsylvania Station.[g] Corn planted May 8 attained its average maximum height of 81 inches on August 8, an interval of ninety-two days, during which time there was a daily mean temperature of 67° F.; a precipitation of 11.5 inches falling on twenty-eight days, of which thirteen days occurred before June 1; and a mean daily cloudiness of 4.9, on a scale of 10.

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[a] Wisconsin Sta. Rpt. 1899, p. 206.

[b] Wisconsin Sta. Rpt. 1900, p. 185.

[c] Wisconsin Sta. Rpt. 1901, p. 197.

[d] Louisiana Stas. Bul. 62, 2d ser.

[e] New Mexico Sta. Bul. 46.

[f] Utah Sta. Bul. 80.

[g] Pennsylvania Sta. Rpt. 1888, p. 167.

A similar study was conducted at the Illinois Station.[a] The experiments extended over four years, and the average growth in height for the first week after the plants were 1 foot high was 11.6 per cent; for the second, 8.3; for the third, 11.3; for the fourth, 14; for the fifth, 20.3; for the sixth, 12; for the seventh, 12.7, and for the eighth, 8.2 per cent. The corn reached its maximum height eight weeks after it was 1 foot high, but in one season, when it was planted as late as June 3, it continued to increase in height for ten weeks after it was 1 foot high. The most rapid growth in height was made when the plants were between 3 and 6 feet tall. They grew 2 feet per week for two weeks in succession the last of June in the season of 1890. Excessive rains in April, May, and June, 1892, interfered with the growth during these months, but about 3 inches in height per day was made in the last week of July. Later work of this kind at the same station[b] led to the conclusion that the rate of growth is to a considerable degree independent of the temperature and dependent upon the stage of development which the corn plant has reached.

## HARVESTING.

The experiments with reference to harvesting were largely conducted for the purpose of determining the stage of ripeness at which corn is most profitably harvested, either for the grain alone or for both grain and fodder. At the Kansas Station[c] dent and flint corn were cut on August 8, 15, and 20, and September 4. An additional cutting of flint corn was made August 24. At the time of the first cutting the corn was in the milk stage, and at the last cutting it was hard and the stalks were drying. The average yield of dry corn increased with both varieties from one date of cutting to the next. The yield of grain from the earliest cutting was 15.36 and 29.69 bushels, and from the latest cutting 39.42 and 61.44 bushels per acre for the dent and flint corn, respectively.

In similar work of this kind the Pennsylvania Station[d] found, by analyses made of silage, dent, and flint corn varieties at different stages of growth and degrees of ripeness, that while the percentage of water decreased as the plant grew the absolute amount of water increased, and that there was a rapid increase of dry matter per acre as the plants approached maturity. In many instances the amount of dry matter in mature stover alone was equal to or more than that of the total crop in any other period of growth. The results further called attention to the fact that there is considerably less water to be handled in proportion to the amount of actual food material when the plants are allowed to mature than when they are cut and used when the kernels begin to glaze. In a later experiment[a] a comparison was made of cutting the stalks just above the ear or close to the ground on September 23 and of allowing the corn to ripen in the field without cutting. The largest yield of ears was obtained where the corn ripened fully before cutting the stalks. Topping the stalks when the kernels were dented reduced the yield of ears, and the reduction was still greater when the whole plant was cut. The same general results were obtained with the stover. The top was about one-third the weight of the total yield of stover and only about one-eighth of the weight of the ears and stover taken together. As compared with gathering the ears after the plants were fully ripe, topping resulted in a yield of 1,050 pounds of stover, obtained at a loss of 540 pounds of ears per acre.

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[a] Illinois Sta. Bul. 31.

[b] Illinois Sta. Bul. 42.

[c] Kansas Sta. Rpt. 1888, p. 42; Bul. 30.

[d] Pennsylvania Sta. Rpt. 1888, p. 26.

Experiments at the Wisconsin Station[b] prior to 1899 showed that flint corn should be cut when it has just passed the glazing stage and dent corn when the kernels are well dented, and that this stage, owing to the small proportion of water present, is favorable to good preservation in the silo and the production of sweet silage. Pride of the North corn was cut at the New York Cornell Station[c] on different dates, from August 2 to September 24, and analyzed. The percentage of protein gradually diminished, while that of carbohydrates and fiber increased as the plant matured. Between the first and last cutting the dry matter and carbohydrates increased about 150 per cent, the fat about 125 per cent, and the protein nearly doubled. In earlier work it was observed that the total feeding value from tasseling until ripening increased 166 per cent.

At the Iowa Station[d] Leaming corn was cut on September 20 and 27 and October 6 and 12, and its composition at these different dates determined. It is concluded from the results that the stover had reached its full development by September 27, while the ears did not reach their maximum growth until October 6. The increase in dry matter of the whole plant was found to be but slight after September 20. The complete ripening of the ear resulted in a loss of 17 per cent of dry matter to the stalks and leaves. It is believed that the corn should have been cut between September 27 and October 6, and that, in general, corn cutting should begin when the blades and husks have begun to dry and that it should be finished when half the blades and husks have dried up. At the Illinois Station[e] corn cut early, with the ears mostly in a roasting-ear stage and the husks and leaves green, yielded 2,521 pounds of corn per acre; harvested when most of the ears were glazed and a few husks and leaves were becoming dry, the yield was 3,232 pounds; and when the corn was fully ripe, 3,874 pounds.

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[a] Pennslyvania Sta. Rpt. 1891, p. 58.

[b] Wisconsin Sta. Bul. 19.

[c] New York Cornell Sta. Bul. 16.

[d] Iowa Sta. Bul. 21.

[e] Illinois Sta. Bul. 31.

At the New York State Station [a] in 1889 five cuttings of silage corn were made from July 30 to September 23. The greatest weight of green fodder was obtained between the periods of full silking and the milky stage of the kernel. After this period the total weight decreased, while the total dry matter increased. As the corn approached maturity the percentage of amid nitrogen diminished and that of albuminoid nitrogen increased. The amount of sugars and starch increased rapidly during the latter part of the growing period. Experiments along this same line at the Vermont Station [b] indicated that varieties of corn ripening in the latitude of the station should be cut as soon as they glaze, while the later large-growing silage varieties should be allowed to stand as long as possible. The total value of products obtained by the Georgia Station [c] when the corn was cut and shocked was $26.69 per acre, as compared with $20.66 from harvesting the ears and blades, and $17.10 from gathering the ears alone. Harvesting the entire stalk of corn at the usual time in August was more economical than letting the stalks stand and harvesting only the ears in October. The results obtained at the stations in the South have shown that, in general, harvesting the leaves for fodder before the crop is mature is unprofitable.

### STORING.

The experiments in storing deal largely with the shrinkage or loss of weight in the crop after harvesting. At the Kentucky Station [d] the shrinkage in the weight of field-cured corn, spread over the floor of a barn loft, from November 11 to January 24, averaged 18.4 per cent. These and later tests also showed that apparently no connection existed between the fertilizers applied to the crop and the shrinkage of the corn in curing.

The shrinkage of unshelled corn from November to March at the Rhode Island Station [e] amounted to 20 per cent in Rhode Island Capped, 21 per cent in Huron Pure Yellow, 8 per cent in Minnesota King, 7 per cent in Conqueror, and 22 per cent in Early Mastodon. The Rhode Island Capped is a white flint variety and the others are dent corns. In a second test unshelled Leaming and Rhode Island

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[a] New York State Sta. Rpt. 1889, p. 86.

[b] Vermont Sta. Rpt. 1889, p. 91.

[c] Georgia Sta. Buls. 23, 30, 46, 62.

[d] Kentucky Sta. Bul. 26.

[e] Rhode Island Sta. Rpt. 1895, p. 312.

Capped lost during four months 13.5 and 7.5 per cent, respectively, and shelled corn of these same varieties 14.4 and 7.4 per cent.

At the Iowa Station[a] a crib holding 7,000 pounds of husked corn was built upon a pair of scales and weekly weighings made during one year. From October to January the loss in weight was 9 per cent; from January to April, $5\frac{4}{7}$ per cent; April to July, $3\frac{1}{7}$ per cent; July to October, $2\frac{5}{7}$ per cent, the total loss for the year being a little over 20 per cent. In a second experiment of this kind[b] begun October 24 the corn under test had lost 12.60 per cent in weight by February 27. The shrinkage in Mammoth Red, Kegley Golden Beauty, Iowa Silver Mine, and Yellow Farm for nine months after husking and cribbing ranged from 21.09 to 22.05 per cent among the four varieties. Nash Early Yellow, which was perfectly matured when a test was begun October 31, showed a shrinkage of 4.93 per cent on January 9, while in Reid, harvested in an immature condition, the loss in weight for the same period amounted to 17.49 per cent.

The loss in weight in corn when the entire plant was stored in the silo, as shown in work conducted at the Michigan Station,[c] is quite marked. Four tests showed an average loss of 8.32 per cent. In some instances the loss varied from 14.57 to 20.36 per cent. The Connecticut State Station[d] in observations made on the entire corn plant cured in the field found that the variations during subsequent storing depended upon the dryness of the air. In one case 4.8 tons of cured fodder which had been cut September 1 weighed 7.5 tons on February 8 following, and in another 25.5 tons of green corn weighed 5.2 tons after curing on November 11 and 8.5 tons by February 8. Corn husked when very damp and cribbed early in October lost 30 per cent in weight by the middle of February, while dry corn cribbed October 21 lost 11 per cent by the last of January. Other cases on record show a shrinkage of less than 3 per cent by January 1, and losses of 9 to 20 per cent during an entire year are recorded for ear corn which was quite dry when put in the crib. At husking time the cob represents fully one-fourth of the total weight of the ear, but when properly stored until spring its weight decreases to less than one-fifth of the weight of the ear. An experiment with shelled corn showed a loss of 7.45 per cent from October to March, while the loss in the cobs was fully 36 per cent.

## ENSILING AND SILAGE.

An exhaustive study of this subject was made by the Wisconsin Station.[e] In 1888 six silos were filled in August and September with fodder corn of different varieties and in different stages of curing. The material was run through a feed cutter and cut into half-inch slices before putting into the silo. The shocked fodder with which the silage was compared remained in the field for a month and was then stored in a barn. Two of the silos recorded temperatures of 100° and 122° F. during the first week, after which the temperature went down slowly and steadily. In the average of two trials fodder in the shock lost 27.58 per cent of dry matter and the material in the silo 26.6 per cent. In the opinion of the station the results indicated that corn fodder should be stored away and protected from rains as soon as it is cured or be put into silos immediately it is wilted. Siloed corn as compared with mature dry corn showed a loss of 24.34 per cent of dry matter in the kernels. The following year[a] four silos were filled with three varieties of corn and a part of the same crop of each variety was cut and shocked in the field at the time the silos were filled, a portion being brought to the barn and stored after a month's standing, and the remainder left in the field until wanted for feeding. The results indicated that with a tight silo and fodder at the right stage of maturity corn can be preserved in the silo with a loss of about 16 per cent of nutritive matter. In 1890[b] tank silos were filled on September 2 with 1,622 and 1,779 pounds of matured and green fodder corn, respectively. On December 10 the silage from matured corn showed a loss of 137 pounds, or about 8½ per cent. The total loss from ensiling, including spoiled silage weighing 223 pounds, was 22.2 per cent. Analysis showed that the loss in weight of dry matter was 26.1; of crude protein, 30.2, and of ash, 30.8 per cent. Owing to the small quantity ensiled, the percentage loss was large. The silage from the green fodder corn had lost 111.5 pounds, or about 6.3 per cent; the spoiled silage in this case weighed 167 pounds, making a total loss of 15.7 per cent. The loss in weight of dry matter was 8.3 per cent; of crude protein, 14.8, and of ash, 12.7 per cent. The good silage was light green, of aromatic odor, and very sour. These results are considered as indicating that the more watery the fodder ensiled the smaller is the loss of dry matter, but the greater the acidity of the silage obtained. The mature corn did not pack as well in the silo as the green corn, and hence sustained a greater loss. The average results of this kind of work carried on by the station up to this time, comprising ten different experiments, indicated that the loss of dry matter in the silo had amounted to 20.5 per cent, and that of crude protein to 20.6 per cent.

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[a] Iowa Sta. Bul. 45.

[b] Iowa Sta. Bul. 77.

[c] Michigan Sta. Bul. 191.

[d] Connecticut State Station Rpt. 1878, p. 65.

[e] Wisconsin Sta. Rpt. 1888, p. 67.

In the fall and winter of 1890[c] the losses in 65 tons of corn put into a single silo and in field-cured corn left out of doors most of the winter were compared. In the silage the loss of dry matter was 10.3 per cent and of protein 12.5 per cent. In the field-cured fodder the loss of dry matter was 28.3 per cent and of protein 34.8 per cent. The average losses in ensiling and in field-curing corn, as determined during the last four years' experiments at this station, amounted to 15.6 per cent and 16.8 per cent for dry matter and protein, respectively, for the silage, and 23.8 and 24.3 per cent for dry matter and protein, respectively, for the field-cured fodder. In September, 1891,[a] four compartments of a silo were filled with Pride of the North corn run through a feed cutter, two being filled with plants retaining the ears and two with plants from which the ears had been removed. The silos were small and the losses in dry matter were quite marked, being 15.8 per cent in the silage with ears and 24.2 per cent in the other. By ensiling ears and all 19,950 pounds of dry matter were obtained in the silage, and by preserving the stover and corn separately 18,608 pounds of dry matter were secured, representing a loss of nearly 7 per cent by handling the corn crop separately instead of ensiling the entire plant.

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[a] Wisconsin Sta. Rpt. 1889, p. 127.

[b] Wisconsin Sta. Rpt. 1890, p. 215.

[c] Wisconsin Sta. Rpt. 1891, p. 227.

The more recent experiments at the station [b] have been in the line of determining the changes occurring in the formation of good silage. The results indicated that good silage can be made under conditions which exclude bacterial activity, and that the initial heating of silage is due mainly to the respiratory processes of the cut plant tissues themselves. First-class corn silage was made in numerous instances in small receivers, the temperatures of which never exceeded 75° to 80° F. It is concluded that the acids of silage are a product mainly of intramolecular respiration and that the degree of acidity is dependent upon the duration of the respiration of the cells. The results obtained are considered as explaining the presence of large amounts of acids in silage from immature and succulent crops. The putrefactive changes occurring in silage are due to bacteria capable of developing under anaerobic conditions in the succulent tissues. That the peculiar aroma of good silage can be produced under conditions in which all vital processes are suspended is taken as an indication that enzyms are operative in this connection.

It is stated that the unavoidable losses in silage are due to the formation of water, carbon dioxid, and volatile organic acids, resulting from the intramolecular respiratory processes of the material put into the silo. The avoidable losses are due mainly to the decomposition of organic matter by bacteria and mold. The admission of air by imperfectly constructed silos facilitates the growth of these organisms and prolongs the direct respiration of the plant tissues. Bacterial activity, instead of being essential, was found deleterious, being most marked where putrefactive changes occurred.

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[a] Wisconsin Sta. Rpt. 1892, p. 53.

[b] Wisconsin Sta. Rpts. 1900, p. 123; 1901, p. 177.

The carbon dioxid found in the silo is evolved by the intramolecular respiration of the ensiled tissues, while the nitrogen is considered as coming from the entangled atmospheric air originally present when the silo is filled. In good silage, where putrefactive changes do not occur, the gases associated with putrefactive fermentation are not found.

At the same station[a] a study of the unavoidable losses in silage was made. The material was ensiled under the complete exclusion of air, but permitting so much as would be entangled in the material when filling the silo. From the loss in weight during the first fifteen days the author concludes that in 100 tons of corn silage under similar conditions the loss of dry matter would have been between 1.27 and 1.62 tons.

In another test in this connection the gaseous products given off from corn silage were measured. In 105 days one sample lost 3.31 per cent of its green weight, and another 3.24 per cent in 59 days. The total amount of gas collected in the first-mentioned experiment was 20.10 cubic feet, and in the second 17.05 cubic feet, or from three to four times the volume of the silage, and on the average 74.02 and 72.24 per cent, respectively, was carbonic-acid gas.

In the report for 1901[b] a study of the causes operative in the formation of silage is reported. The temperature produced, the loss in weight, and the amount of gases evolved were determined. Cut field corn of average maturity was placed in two galvanized-iron receptacles 1½ feet in diameter and 4 feet high. These silos were then hermetically sealed, and remained closed for twenty-five days. The initial maximum temperature was reached the first day after filling. For twelve days the temperature remained above the room temperature, after which it fluctuated with the same. When opened the silage was in good condition and showed no evidence of mold or bacterial decomposition. Three days later the temperature of the silage began to rise rapidly, reaching its maximum at about 50° C., or 20° above the initial heating after about ten days, when the temperature again fell, but never reached that of the room. The total loss in the weight of silage before opening, representing the unavoidable losses, was about 1 per cent. After the silos were opened the loss in weight was small until the temperature began to rise, when it increased rapidly, and amounted to nearly 1 pound per day as the maximum temperature was reached. It is assumed that if the gas evolved was carbon dioxid the loss in weight due to the evolution of this gas would approximate 1 per cent, or practically the same as shown by the actual diminution of weight in the silage. From the results it is concluded that the normal changes in silage are due to direct and intramolecular respiration of the plant cells themselves, and that normally bacteria and mold are detrimental only when air finds access to the mass of plant tissues in the silo.

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[a] Wisconsin Sta. Rpt. 1900, p. 189.

[b] Wisconsin Sta. Rpt. 1901, p. 177.

The relation of plant-cell activity to silage formation was studied by placing the immature cut corn in a receiver and immediately freezing the same to destroy cell activity. This was compared with the sample ensiled in the usual way. One frozen sample was treated with ether. After twenty-two days, when all samples were opened, only the sample treated in the usual way had a distinctly silage aroma, while the other samples had a decidedly offensive odor, suggestive of putrefaction. It was concluded that if the silage changes were attributable to bacteria, the frozen corn should have made as good silage as the other. Practically the same amount of acidity was found to have developed in all samples as the result of bacterial growth, but in the frozen samples treated with ether the acidity was very much lower. It is believed that, owing to the immediate destruction of the life of the plant cells, the changes which characterize silage formation did not take place. A number of samples of the same lot of corn were ensiled and opened on different dates to determine the relation of aroma production to death of plant cells. The characteristic aroma of silage was observed at early stages, before the plant cells had died, and it is believed, therefore, that the internal processes of the living plant cell, rather than the growth of enzyms, are the factors that inaugurate the series of changes resulting in the production of good silage.

A study was also made of the effect of close packing of corn in the silo on the unavoidable losses in silage. Well-matured corn was ensiled in pint and quart bottles, packed at different degrees of density. The loss of weight in the material was determined at thirty-three and three hundred and three days. The average loss in loosely packed silage was nearly three times as large as in the closely packed silage; the closely packed samples came to a constant weight in eight and nine days, while the other samples continued to lose for twenty-eight and thirty days. In studying the silage gases it was found that the air in the silo becomes rarefied. In one experiment silage exposed to the air did not mold, and lost in weight only 3 pounds, or 4 per cent, from May 15 to September 18. This silage, although appearing normal, was less acid than ordinary silage and had a distinctly abnormal taste. Forcing air through a silo did not injure the appearance of the silage, but gave it a bad odor and made it unpalatable. From the data obtained it is concluded that during the early stages of the ensiling processes carbon dioxid is given off in large volumes, and that nitrogen other than that of the residual air is likely to be proven to be a notable component of the gases of normal silage at all times. Water, vapor, and other volatile products escape with the gases of normal silage at all times, but their quantitative relations have not yet been determined with sufficient accuracy. The more loosely silage is packed in the silo and the larger the volume of entangled air, the greater will be the unavoidable losses, and the more open and porous the walls the larger will be the volume of air drawn into the silos. It is pointed out that by making the silo as nearly air-tight as possible the silage breathing could be materially reduced and the losses consequently lessened.

Silage and dry fodder from corn cut at different periods of growth were compared at the Michigan Station.[a] The first cutting was made August 10, and subsequent cuttings were made at intervals of about a week, the last cutting being made September 14, when the corn was ripe. The results showed that while the weight of green stalks did not vary widely, the amount of dry matter increased steadily from 2,672 pounds per acre to 4,536 pounds at the last cutting. The percentage of dry matter in the silage steadily increased from 10 per cent on August 10 to nearly 30 per cent on September 14. The estimated amount of dry matter in the silage from 1 acre increased from 1,920 pounds to 4,411 pounds, and the loss of dry matter by ensiling varied from 752 pounds to 125 pounds per acre. The amount of acid fell from 1.26 per cent to 0.70 per cent. These results are taken to indicate the loss occasioned by using succulent and immature corn for silage and the advantage of using corn that is nearly ripe. The ash in the corn and in the silage showed a steady decrease with the increased age of the plant. The crude fiber remained quite uniform in the cornstalks, but decreased in the silage from 29.41 to 22.98 per cent, showing that with the ripened stalks in the silo a larger amount of the crude fiber is made digestible and assimilable. The ether extract was increased nearly 75 per cent in the silo. With reference to nitrogen-free extract, it is stated that the content of 49.04 per cent in the first cutting of corn represented only 1,310 pounds to the acre, while the 57.02 per cent at the last cutting represented 2,576 pounds; and in the silo 45.68 per cent of the nitrogen-free matter in the first cutting represented only 876 pounds, while 58.65 per cent in the last cutting represented 2,587 pounds of carbohydrates. The nitrogenous constituents showed a falling off in percentage, but an actual increase for the whole product. In later experiments[b] the loss in the silo of corn cut at different stages of growth was studied. The corn was cut August 10 and 25 and September 6 and 15, and the losses sustained in the dry matter by November 22 and 27 for the August and September cuttings, respectively, amounted to 20.08, 24.81, 22.01, and 26.80 per cent for the different dates in the order mentioned. The loss of weight in corn[a] where the entire plant is stored in the silo was found to be quite marked. Four tests showed an average loss of 8.32 per cent. In some instances the loss varied from 14.57 to 20.36 per cent. A record of silo temperatures and of changes in weight in ensiled fodder corn was made at the Vermont Station.[b] A small wooden tank silo was filled with cut fodder corn, closely packed and covered. The highest temperature, 80° F., was reached the second day after the silo was filled. There was a loss in ensiling of 14.67 per cent of the total dry matter in the original material, and this loss was almost entirely in nitrogen-free extract. A comparison was also made[c] of ensiling and field-curing corn with and without the ears, the ears being ground in the latter case and fed with the stalks from which they were taken. The losses in dry matter, albuminoids, and carbohydrates were about the same for all cases. The ears in the silo lost more of their food value than those handled in other ways. In dry matter the loss amounted to about 20 per cent, being represented largely by the loss in carbohydrates. From experiments conducted by the New Hampshire Station,[d] it was concluded that the corn plant has reached its maximum food production when it is nearly matured, with the ears fully formed and well filled, and that at this stage it is best fitted for silage. Leaming dent corn was found the most desirable variety, and for the portions of the State where the season is too short for this variety to reach the proper stage Sanford flint corn is recommended. In comparing the feeding value of Sanford, Leaming, and Mosby Prolific, the results seemed to place Sanford silage highest and Mosby Prolific lowest. A chemical study of the silage showed that the sugar in the green fodder was practically all destroyed in the silo, and it is therefore suggested that cutting be postponed until the grain is full sized and the sugars have been changed largely to starch. During the years 1895 to 1899[e] the acidity of silage was studied. The average total acid content of samples of Sanford corn silage varied from 1.05 per cent acetic acid in 1895 to 1.95 per cent in 1897. With Leaming corn the variations ranged from 0.67 per cent in 1896 to 1.47 in 1897. The average of five samples of Mosby Prolific taken between March 17 and 31, 1896, was 0.82 per cent. Analyses in 1899 of silage made from Leaming corn showed that the acidity of the surface silage was usually lower than that of the silage 6 or 8 inches below the surface, the average results being 0.83 per cent for surface silage and 1.03 per cent acetic acid for silage not less than 6 inches below the surface.

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[a] Michigan Sta. Bul. 68.

[b] Michigan Sta. Bul. 154.

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[a] Michigan Sta. Bul. 191.

[b] Vermont Sta. Rpt. 1889, p. 96.

[c] Vermont Sta. Rpts. 1892, p. 182; 1894, p. 168.

[d] New Hampshire Sta. Bul. 92.

[e] New Hampshire Sta. Bul. 96.

The Pennsylvania Station[a] found that silage lost about one-half as much dry matter by fermentation as field corn did by fermentation and mechanical losses together; the silage lost about two-fifths as much total protein as the fodder, but over one-fourth of its albuminoids was converted into nonalbuminoids, while in the field-cured fodder there was no evidence of any such conversion. The silage lost no woody fiber, while the cured fodder, evidently from the breaking off of parts during handling, lost considerable in this ingredient. The loss of starchy matter was about in proportion to the total loss of dry matter, being slightly greater relatively in the fodder than in the dry silage. The New Jersey Stations[b] found that the cost of harvesting, storing, and preparing the dry matter contained in corn was greater in the form of silage than in the form of dry fodder, and that more is realized from corn fodder when preserved and fed in the form of silage than as fodder. The Utah Station[c] filled two silos with green corn fodder and one with corn stover. The average loss of dry matter in the green corn silage was 17.1 per cent and in the stover 25.1 per cent. The changes in the composition of stored dry corn fodder were decidedly less important than in the corn preserved in the silo. Corn fodder stored in the silo after drying for two weeks kept better than any of the other lots. None of it had spoiled; it showed no loss by analysis, and gave the appearance of having been kept in an ideal condition.

## CORN BREEDING.

Experiments in the improvement of corn by cross fertilization and selection are reported for several stations. In the method of cross fertilization followed by the Kansas Station[d] the tassel when the pollen was about to be discharged was inclosed in a paper or cloth bag, and the ear just before the emergence of the silk was also covered. The bag over the tassel of the variety whose pollen was desired was removed and taken to the ear to be fertilized, the pollen being sprinkled on the exposed silk after the covering had been removed. The ear was then again covered until the silk was entirely withered, and often until the grains were ripe and the ears removed from the stalk. This line of work was followed from 1888 to 1890, and the results in general show that numerous crosses by means of artificial pollination were mostly successful, and that the different races, as dent, flint, soft, sweet, and pop corn apparently crossed readily. The effects of crossing were in comparatively few cases, generally in sweet-corn varieties, visible the first year. The second generation usually showed ears more or less completely blended and often exactly intermediate between the two parent types. More rarely the grains of a single ear were unlike each other, resembling closely or remotely either parent. The third year the produce was generally true to the seed planted.

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[a] Pennsylvania Sta. Rpt. 1889, p. 113.

[b] New Jersey Stas. Bul. 122.

[c] Utah Sta. Rpt. 1892, p. 40.

[d] Kansas Sta. Rpts. 1888, p. 316; 1889, p. 288; Bul. 17.

In 1891 [a] some blue kernels found on ears of corn whose intermediate parents were known to have shown no kernels of this color were planted and one of the resulting ears was fertilized with pollen from the same stalk under conditions which kept it free from any possible intermediate cross. This ear contained 370 kernels, of which 206 were blue, 71 pink, 71 orange-yellow, and 22 pure white. Five other ears from the same seed exposed to the pollen of other varieties showed the same variation in color, with a slightly smaller percentage of blue. The prepotency of blue corn was studied by examining a large number of ears from other plats growing within a radius of 25 yards, and it was found that about half the number of uninclosed ears had from one to five blue kernels, while not one of the inclosed gave any trace of blue.

In connection with later work on the improvement of corn,[b] analyses were made of varieties, single ears, and single kernels, to determine their nitrogen content. In thirty-three varieties under investigation the nitrogen ranged from 1.56 to 2.26 per cent. In different ears of a variety grown for thirty years without admixture it ranged from 1.53 to 2.24 per cent, and in ears of a cross originated the previous year, from 1.35 to 2.22 per cent. The nitrogen content of single kernels from the same ear varied considerably, but not to an extent as great as among different ears of the same variety. It was also found that the specific gravity of kernels is too uncertain a factor for the selection of corn rich in nitrogen. Of the original thirty-three varieties, twenty-one were selected for breeding purposes, and after three years the crosses obtained showed remarkably high percentages of nitrogen in many cases; all of them contained 2 per cent or more. In twelve cases the average was about 2.40 per cent of nitrogen, or 15 per cent of protein.

Breeding experiments at the Iowa Station[c] gave better results from planting corn in an isolated part of the field, removing the tassels and hand-pollinating the ears without covering, than by the method of covering the tassels and silks with sacks. The pollen was best applied before sunrise.

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[a] Kansas Sta. Bul. 27.
[b] Kansas Sta. Bul. 107.
[c] Iowa Sta. Bul. 13.

At the Minnesota Station[a] Mercer Yellow Flint corn in proximity to Black Mexican Sweet corn produced several black grains on some of the ears. A dozen of these dark-colored grains were planted and protected from pollen from other varieties. The ears produced showed that the Black Mexican corn had fertilized dark-colored grains on the ears of Flint corn the previous year. Besides the Yellow Flint and the Black Sweet grains there were Yellow Sweet, Black Flint, White Sweet, and White Flint grains on nearly every ear, which is taken as showing the ancestry of this cross. It is suggested that both parents had been crossed with different varieties, and that the different ancestral characteristics reappeared, and from these results the importance of keeping seed pure is pointed out.

The Rhode Island Station[b] planted Longfellow flint corn in close proximity to sweet corn, but the resulting ears failed to show any kernels of the sweet-corn type on the ears of the flint corn, although the yellow kernels were very numerous on the sweet corn, being mostly found on ears taken from rows next the yellow corn. In selection experiments[c] the lowest ear on the stalk used for seed showed no greater tendency toward improving ear production than the use of the highest ear. It is concluded that for the increase in ear production the best developed seed should be secured from plants producing the largest number of ears, regardless of the position the ear occupies on the stalk.

In 1892 the Illinois Station[d] reported on corn-breeding experiments begun in 1889. Crosses were made between varieties of dent corn, and varieties of dent, sweet, and pop corn. In none of the crosses made between different varieties of dent corn of the same color or between different varieties of sweet corn of the same color could the change in the crossed ear with any certainty be attributed to the influence of the pollen. The variation in these ears was apparently no greater than in ears of the same variety left to form naturally. Ears produced by crossing white sweet corn with pollen of yellow dent corn were nearly as dark as the male variety, with kernels very much like flint corn in appearance and with a taste characteristic of dent corn, and where both sweet and dent kernels appeared on the same ear the dent kernels were always the heavier. It is stated that color, where it is a character of the kernel and not of the seed coat, tends very strongly to pass from one variety to another. Crosses in which yellow dent corn was the male and white sweet corn the female, yellow sweet the male and white sweet the female, and yellow pop corn the male and white dent the female, exhibited the greatest degree of certainty or success. Of nineteen ears produced by these various crosses only two kernels did not show distinctly the effects of the pollen. Of sweet-corn stalks bearing two ears, one crossed and the other left to be naturally fertilized, there was no indication of anything but sweet-corn pollen on the naturally fertilized ears. All crosses, except the purely dent-corn crosses, were planted, and during the first growing season the uniformity of the plats was very noticeable. The number of ears to the stalk showed a tendency to follow the same type as the stalk. The ears from each of the crossed plats were as uniform as is common with varieties of corn, and the crosses of different varieties were modified to about the same extent by each parent. The crosses using the pop corn and dent corn as parents seemed to show the effect of the male more than the female parent, while those of which pop corn was the male parent were more flinty than those in which dent corn had furnished the pollen. The corn grown from the crossed seed was, in nearly all cases, increased in size as a result of the crossing.

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[a] Minnesota Sta. Bul. 11.

[b] Rhode Island Sta. Rpt. 1898, p. 106.

[c] Rhode Island Sta. Rpt. 1903, p. 206.

[d] Illinois Sta. Bul. 21.

The second year the corn continued to be comparatively uniform in type where the parent varieties were similar, but where they were different, as in the crosses between sweet and dent, the progeny tended strongly to run back to the parent forms, while at the same time taking on other forms different from either. Nearly all the corn grown the second year was smaller than that grown the first year, although most of it larger than that of the parent varieties. Some of the varieties which might be supposed to be most nearly related, as the sweet corns, have shown very little increase when grown from crossed seed, while two varieties of pop corn, which would seem as nearly related to each other as the varieties of sweet corn, gave a very decided increase in size when grown from crossed seed. Corn from the cross of Black Mexican and White Dent, two widely differing varieties, showed a decrease in size, while that from flour corn and Golden Coin, varieties apparently as widely different as any crossed, gave ears showing the greatest proportion of gain in size. There seems to be a strong tendency in the progeny of the crosses of different varieties of dent, sweet, and pop corn toward the flint type.

In 1892[a] in each of five cases the yield from plats of crossbred corn was larger than the average yield of plats planted with varieties which had not been crossed, the average increase being over 9 bushels per acre. In 1893[a] it was observed that in every instance seed from cross-fertilized ears produced a larger yield and larger stalks than seed from self-fertilized ears, but the ears of the latter were more uniform in character. In another test in three out of four cases the yield from crossbred seed was greater than the average yield of the parent varieties, the average difference being 2.3 bushels per acre. In 1894[b] the seed from cross-fertilized plants selected in 1892 and 1893, together with the seed from both parent varieties, was grown and the average increase from the cross-fertilized seed was 12 bushels per acre.

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[a] Illinois Sta. Bul. 25.

The later work in corn breeding at this station[c] has been along the line of improving the chemical composition of the kernel. In six tests the selection of seed corn of high and low protein content produced differences in the composition varying from 0.50 to 1.25 per cent of protein, and the selection of seed of high and low fat content differences ranging from 0.67 to 1.45 per cent of fat. The relation of the size of the kernel to the percentage of protein or fat was also investigated. The weight of kernels from 24 ears high in protein averaged 0.372 gram per kernel; from 16 ears low in protein, 0.337 gram per kernel; from 12 ears high in fat, 0.345 gram, and from 16 ears low in fat, 0.42 gram per kernel. In general the tendency of corn high in fat content was toward small kernels, and vice versa. In studying the relation of corn germ to kernel it was found that the percentage of germ to kernel is correlated with a high fat content. From the results it is concluded that by proper selection of seed the protein, fat, or carbohydrates of corn may be increased or decreased. The following method[d] of maintaining a breeding plant is recommended:

> Forty selected ears are planted in forty separate parallel rows, one ear to a row. Consequently the breeding plat should be at least forty corn rows wide and long enough to require about three-fourths of an ear to plant a row. It is well to shell the remainder of the corn from all of the forty ears, mix it together, and use it to plant a border several rows wide entirely around the breeding plat to protect it, especially from foreign pollen. * * * The very best ears of seed corn are planted in the center rows of the breeding plat, the remainder of the ears being planted in approximately uniform gradation to either side, so that the least desirable ears among the forty are planted in the outside rows, and in the final selection of the best field rows from which the next year's seed ears are to be taken some preference is given to the rows near the center of the plat.

In further work along this line[e] the chemical and physical composition of the corn kernel was studied. The kernel is considered as consisting of the tip cap, hull, horny gluten, horny starch, white starch, and germ. The tip cap is described as covering the tip or base of the kernel and comprising 1.5 per cent of the grain, and the hull is the very thin outer coat comprising about 6 per cent of the kernel and containing a smaller percentage of protein than any other part of it. The horny gluten, lying immediately under the hull, comprises from 8 to 14 per cent of the grain and is more abundant in the kernels with a high protein content. This part contains from 20 to 25 per cent of protein and is the richest in this substance of all the parts of the kernel. The horny starch, the chief substance in the sides and back of the kernel, comprises about 45 per cent of ordinary corn, but the percentage is much higher in corn with a high protein and lower in corn with a low protein content. This part of the kernel is rich in starch and contains about 10 per cent of protein, a greater total amount than any other part. The white starch, occupying the center of the crown end of the kernel and usually partially surrounded with germ, comprises about 25 per cent of the kernel, being less in high-protein corn and greater in low-protein corn. It contains only from 5 to 8 per cent of protein. The germ comprises about 11 per cent of the kernel and varies according to the oil content, constituting a higher proportion in high-oil corn and a smaller proportion in low-oil corn. The oil in the germ ranged from 35 to 40 per cent, and from 80 to 85 per cent of the total oil present. Corn high in protein contains a larger proportion of horny gluten and horny starch and a correspondingly smaller proportion of white starch. In corn of a high protein content the horny parts comprise over 60 per cent of the kernel and contain about 80 per cent of the total protein.

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[a] Illinois Sta. Bul. 31.

[b] Illinois Sta. Bul. 37.

[c] Illinois Sta. Bul. 55.

[d] Illinois Sta. Bul. 82.

[e] Illinois Sta. Bul. 87.

Two strains of corn bred for four years for a high-oil and low-oil content showed an average difference of 1.97 per cent in the oil content and 0.18 per cent in the protein content, or less than 5 per cent of a perfect correlation between oil and protein. It is concluded that as the percentage of protein increases the starch decreases and the oil content remains practically unchanged, and that the selection of high-protein seed corn should be governed by a high proportion of horny parts, and of high-oil seed corn by a large proportion of germ. In a study of four strains of pedigreed corn, the crop representing the seventh generation, the protein content of low-protein ears varied from 6.36 to 7.9 per cent, with an average of 6.71 per cent, while the protein content of the high-protein ears varied from 13.98 to 15.01 per cent, with an average of 14.44 per cent. The average oil content of the low-protein ears was 4.21, and of the high-protein ears 4.93 per cent. In a further test of the composition of the kernels a slight correlation between oil and protein again became apparent, the high-oil corn containing nearly three times as much oil as the low-oil corn, but being less than one-seventh richer in protein. A very marked correlation between oil and germ was shown, the low-oil ears containing an average of 2.52 per cent of oil and 7.74 per cent of germ, and the high-oil ears an average of 7 per cent of oil and 13.84 per cent of germ.

The effect of breeding in changing the composition of the different physical parts of the kernel is shown by the fact that the germs from the low-oil corn contained about 25 per cent of oil and those from the high-oil corn nearly 42 per cent, while the endosperms from the low-protein ears contained less than 6 per cent of protein and those from the high-protein ears nearly 14 per cent. Breeding for high or low protein produced no marked effect upon the ash content or the oil content of either the germs or the endosperms, and only slightly influenced the protein content of the germs. As calculated on the basis of 100 pounds of corn, there was a maximum difference of only 0.75 pound of protein in the germs from 100 pounds of low-protein and high-protein corn, and a difference of 7.06 pounds of protein in the endosperms.

At the North Dakota Station[a] corn selected for high nitrogen content in 1901 gave in most cases corn of high nitrogen content in 1902, but the crop of 1903 presented some marked variations. The physical method of selecting corn of a high nitrogen content was found quite reliable.

### COMPOSITION OF CORN.

Numerous analyses of the different parts of the corn plant at different stages of growth and at maturity have been reported by the stations from time to time. According to a summary of the results obtained by the New York, New Hampshire, and Pennsylvania experiment stations[b] the average gains for all trials between the time of cutting corn when in bloom or tassel and when ripe or glazed, amounted to 205 per cent in dry matter, 114 per cent in albuminoids, 230 per cent in fat, and 265 per cent in carbohydrates.

The effect of fertilizers on the composition of corn was studied by the Vermont Station[c] and it was observed that there was a noticeable increase in the dry matter of the crop only when phosphoric acid was used. The proportion, as well as the total amount of starch, was highest when phosphoric acid was present in abundance in the fertilizer and lowest when potash was used instead of phosphoric acid. Assuming that the differences in produce were due to the fertilizers, the addition of nitrogen alone appeared to increase the percentage of nitrogen or albuminoids in the crop. The addition of potash or of nitrogen and potash did not change the percentage of nitrogen. Phosphoric acid alone or in combination lowered the percentage of nitrogen, but each time so increased the weight of the crop that more nitrogen was taken from the soil than when nitrogen compounds alone were used. It is concluded that the analysis of the plant does not show the needs of the soil. In several of the trials large amounts of nitrogen were supplied in the fertilizer, yet the crop contained even more, which is taken to show that corn does not need much of an artificial supply of nitrogen and that if plenty of phosphoric acid and potash is given it will supply itself with nitrogen from the soil and produce a good crop. The effect of frost on the composition of corn fodder was also studied.[a] Corn was cut October 24, when somewhat frosted, and November 13, after several severe frosts had occurred. The latest cutting, as compared with the first, showed a loss of 31 per cent in albuminoids, 9.7 per cent in crude fiber, 22.7 per cent in nitrogen-free extract, 47.6 per cent in fat, and 33.4 per cent in ash.

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[a] North Dakota Sta. Rpts. 1902, p. 30; 1903, p. 38.

[b] New York Cornell Sta. Bul. 16.

[c] Vermont Sta. Bul. 15.

The Maine Station[b] found the increase in dry matter, from August 15, when the ears were beginning to form, to September 21, when all the ears were glazed, to amount to 3,974.7 pounds per acre. The gain in ash for this same period was 130.2 pounds; protein, 191.4 pounds; fiber, 496.7 pounds; nitrogen-free extract, 3,029 pounds; sugars, 802.5 pounds; starch, 1,083 pounds, and fat, 128.7 pounds. Basing its calculation on a yield of 60 bushels of shelled corn per acre, the Delaware Station[c] found that field corn produced twice as much protein, two and a half times as much carbohydrates and fiber, and four times as much fat per acre as the sweet corn. Work on the composition of corn, as affected by fertilizers, has also been followed at the Connecticut Storrs Station.[d] In 128 samples analyzed, the albuminoid nitrogen in the corn varied from 90.96 to 100, and averaged 95.26 per cent of the total nitrogen, and that in the stover varied from 74.36 to 100, and averaged 86.44 per cent of the total nitrogen. The percentage of protein in the corn and stover increased, in general, with the quantity of nitrogen applied. The total amount of protein in the crop was also increased by the use of nitrogen in the fertilizers, even when it did not increase the yield per acre. The variations in the approximate composition of corn and stover were found to be very wide, the greater range being in the stover. In the corn the proportion of protein varied from 8.9 to 13.3 per cent; that of crude fat, from 4.4 to 7.2; of nitrogen-free extract, from 76.9 to 81.9; of fiber, from 1.2 to 2.4; and of ash, from 1.4 to 2.4 per cent in the water-free substance. In the stover the range of protein was from 4.1

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[a] Vermont Sta. Rpt. 1889, p. 72.

[b] Maine Sta. Rpt. 1893, p. 57.

[c] Delaware Sta. Rpt. 1892, p. 37.

[d] Connecticut Storrs Sta. Rpt. 1889, p. 127.

to 11.3 per cent; of fat, from 1.3 to 2.6; of nitrogen-free extract, from 45.9 to 57; of fiber, from 27.9 to 37.3, and of ash, from 4.4 to 9.5 per cent on the water-free basis. The moisture in the samples at the time of harvest varied from 22 to 30.3 per cent in the corn, and from 32.4 to 71.4 per cent in the stover. The approximate composition of corn and stover of New England grown maize was studied by this same station.[a] In general, the use of nitrogen produced a corn richer in protein than the use of mineral fertilizers alone. The variations in the percentage of different constituents showed that the water-free substance of corn kernels grown upon different soils with different fertilizers in different seasons varies greatly in composition. The variations in water content at harvest and in the composition of the water-free substance of stover were much more marked than those of corn, there being an extreme variation of more than 15 per cent of water at harvest and of 7 per cent in the protein. The composition of marketable ears and of soft ears and nubbins of flint corn is also reported.[b] The percentage of protein in soft ears and nubbins exceeded that in good ears by an average of 1.5 per cent, varying in different experiments from 0.75 to 2.3 per cent. Very little difference in the amount of crude fiber was found in the two grades. The percentage of ash was 0.2 per cent greater in poor than in good corn. There was an average of 0.4 per cent more fat or oil in the good than in the poor corn, and the percentage of nitrogen-free extract in the good corn was greater by an average of about 1.4.

Work on the proteids of corn has been conducted at the Connecticut State Station.[c] The proteid constituents of 100 grams of yellow corn meal, together with the nitrogen content of each, are given approximately as follows:

*Proteids in 100 grams of corn meal.*

| | Amount of proteid. | Nitrogen content of proteid. | Amount of nitrogen. |
|---|---|---|---|
| | *Grams.* | *Per cent.* | *Grams.* |
| Proteid soluble in water—proteose | 0.06 | 17.00 | 0.0102 |
| Globulins soluble in salt solutions: | | | |
| Maysin | .25 | 16.70 | .0417 |
| Edestin | .10 | 18.10 | .0181 |
| Very soluble globulin | .04 | 15.25 | .0061 |
| Proteid soluble in dilute alcohol—zein | 5.00 | 16.13 | .8065 |
| Proteid matter soluble in 0.3 per cent potash solution | 3.15 | 15.82 | .4983 |
| Total nitrogen in proteids | | | 1.3809 |
| Nitrogen undissolved by dilute potash solution | | | .1645 |
| Total nitrogen | | | 1.5454 |

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[a] Connecticut Storrs Sta. Rpt. 1890, p. 112.

[b] Connecticut Storrs Sta. Rpt. 1890, p. 26.

[c] Connecticut State Sta. Rpt. 1896, p. 391.

The nitrogen found in corn meal by analysis was 1.54 grams, equal to 15.40 per cent. The average nitrogen content of the corn proteids is given as 16.057 per cent. The total sulphur content of zein is reported[a] as 0.6 per cent.

At the Nebraska Station[b] the air-dried fodder of field corn, cut when the tassels began to appear, contained 13.03 per cent of water, 8.08 per cent of protein, 6.17 per cent of albuminoids, 1.37 per cent of ether extract, 40.43 per cent of nitrogen-free extract, 27.09 per cent of crude fiber, and 10 per cent of ash, as compared with 13.85 per cent of water, 6.69 per cent of protein, 5.49 per cent of albuminoids, 1.38 per cent of ether extract, 45.74 per cent of nitrogen-free extract, 24.04 per cent of crude fiber, and 8.3 per cent of ash when the plants were full grown and some ears had formed. The amount of dry matter in the stalks of a number of varieties from Northern and Southern States, as determined by the Wisconsin Station,[c] ranged from 40.09 to 65.21 per cent, and the percentage of protein in the dry matter from 7.12 to 10.01. In the ears the percentage of dry matter ranged from 29.78 to 76.52, and the percentage of protein in the dry matter from 8.19 to 11.41. In the mature corn the quantity of dry matter in the ears was about equal to that in the stalks and leaves.

The New Jersey Stations[d] report the following analyses of the corn kernel:

*Analyses of whole and separate parts of corn kernel.*

| | Amount secured from 100 parts of original corn. | Water. | Composition of the water-free material. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Crude fat. | Crude fiber. | Crude protein. | Crude ash. | Carbohydrates. | Nitrogen. | Phosphoric acid. | Potash. |
| | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* | *P. ct.* |
| Original corn | 100.00 | 24.74 | 4.34 | 2.02 | 12.65 | 1.73 | 79.26 | 2.02 | 0.83 | 0.47 |
| Skin | 5.56 | 15.29 | 1.59 | 16.45 | 6.60 | 1.27 | 75.36 | 1.06 | .23 | .38 |
| Germ | 10.17 | 29.62 | 29.62 | 2.88 | 21.71 | 11.13 | 45.79 | 3.48 | 6.16 | 2.91 |
| Starchy and hard part | 84.27 | 24.66 | 1.54 | .65 | 12.23 | .68 | 85.58 | 1.96 | .35 | .17 |

These data show that the germ contains 65 per cent of the fat, 61½ per cent of the mineral matter, 71 per cent of the phosphoric acid, 60 per cent of the potash, and 16⅓ per cent of the nitrogen or protein. The germ constitutes about 10 per cent of the whole kernel. The skin contained 51 per cent of the fiber, and the starchy part nearly 90 per cent of the carbohydrates present in the whole grain.

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[a] Connecticut State Stn. Rpt. 1900, pt. 4, p. 455.

[b] Nebraska Sta. Rpt. 1900, p. 75.

[c] Wisconsin Sta. Rpt. 1891, p. 220.

[d] New Jersey Stas. Bul. 105.

The Georgia Station[a] reports the following analysis of different parts of the corn plant:

*Analysis of parts of the corn plant.*

| Parts of plant. | Share of whole plant. | Water. | Crude protein. | Crude fiber. | Crude fat. | Nitrogen-free extract. | Ash. |
|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Butts | 24.14 | 18.76 | 2.12 | 26.36 | 1.09 | 49.64 | 3.03 |
| Top stalks | 5.14 | 20.14 | 4.86 | 24.70 | 1.12 | 46.57 | 2.61 |
| Blades from butts | 6.18 | 21.15 | 6.14 | 25.38 | .90 | 43.28 | 3.15 |
| Blades from tops | 3.65 | 19.62 | 6.20 | 21.73 | 1.04 | 47.31 | 4.10 |
| Shucks | 11.13 | 17.20 | 4.27 | 29.45 | 1.00 | 44.86 | 3.22 |
| Tassels | 1.30 | 19.31 | 5.31 | 30.10 | .87 | 39.30 | 5.11 |
| Grain[a] | 38.77 | 10.80 | 10.20 | 2.20 | 4.90 | 69.30 | 1.50 |
| Cobs[a] | 9.69 | 10.70 | 2.40 | 30.10 | .50 | 54.90 | 1.40 |

[a] Analysis of E. H. Jenkins.

## RELATION BETWEEN DIFFERENT PARTS OF THE PLANT.

The weight of ear per bushel of shelled corn was determined for different varieties at the Illinois Station.[b] It was found that 70 pounds for the early, 73 for the medium, and 78 for the late-maturing varieties tested at the station was sufficient to produce a bushel of air-dry corn at the last of October. The quantity required, however, was found to vary with the season, depending upon the percentage of water in the ears. Tests made February 14, 1901, showed that about 65 pounds of Murdock, an early-maturing variety, 66.5 pounds of Leaming, about 67 pounds of Burr White, and a little over 66 pounds of mixed varieties of Yellow Dent made 56 pounds of shelled corn. When thoroughly air dry, 12 pounds of cob per bushel is considered a maximum for any variety suitable for the latitude of the station, and in case of carefully selected ears, as in seed corn, the weight of cobs per bushel should be less.

The Connecticut Storrs Station[c] determined the ratio of corn to cob in eighty-one partly dried samples. The percentage of water-free corn at harvest varied from 45.3 to 64.1 per cent; so that in the one case 100 pounds of ears would yield 45.3 pounds of water-free corn, or 50.3 pounds of corn with average percentage of water, and in the other case 64.1 pounds of water-free corn, or 71.3 with average percentage of water.

At the Connecticut State Station[d] Rhode Island White Capped Flint increased in the yield of dry shelled corn with the thickness of planting up to a stand of two kernels per foot. The dry weight of leaves increased regularly with the thickness of planting, and that of stripped stalks increased with the thickness of planting up to a stand of one plant per foot. White Edge Dent corn showed the same variations as the flint variety in sound and soft kernels and leaves due to rate of planting, but while the weight of water-free stalks of the flint variety was greatest with one plant per foot, the weight of water-free stalks of the dent variety was greatest with the thickest planting, or eight plants per foot. The proportion of sound kernels of the flint variety to total water-free corn increased with the thickness of planting up to two stalks per foot, while the proportion of kernels of the dent variety to the total crop was greatest where the stand was one stalk per 2 feet. The proportion of leaves to total dry crop in both varieties was largest where the proportion of sound kernels was smallest.

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[a] Georgia Sta. Bul. 30.

[b] Illinois Sta. Bul. 13.

[c] Connecticut Storrs Sta. Rpt. 1889, p. 167.

[d] Connecticut State Sta. Rpt. 1889, pp. 30, 225.

### COST AND PROFIT IN GROWING.

At the Nebraska Station[a] Centennial White corn was grown at a cost of 23.43 cents per bushel, and Leaming, in a different field, at a cost of 14.9 cents. The cost of planting and harvesting Centennial White was $10.17 per acre, and that of Leaming $6.65 in one field and $6.08 in the other; and the corresponding profits per acre were $1.33, $5.16, and $4.72, respectively, the corn being valued at 30 cents per bushel. In observations made at the Pennsylvania Station[b] the cost of growing and ensiling corn was $16.17 per acre as compared with $57.54 for growing, harvesting, and storing sugar beets and mangels. The roots produced 4,615 pounds of air-dry substance and the corn, 6,763 pounds per acre.

An investigation of the expense of raising corn in Illinois was made by the Illinois Station[c] in 1896. Two hundred and seventy-four estimates from farmers throughout the State were used in calculating the cost. The average yield of corn per acre on the farms taken into consideration was 54 bushels, and the cost of production represented the average sum of the expenses on all the processes involved, from the preparation of the soil to the delivery at the elevator, including the wages of the farmer himself. A proper allowance was made for time lost and for maintenance of team during idleness, interest on investment, including rent, and allowance for depreciation of tools and machinery. On this basis the calculated cost of production of corn was 19.5 cents per bushel and $10.59 per acre.

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[a] Nebraska Sta. Bul. 29.

[b] Pennsylvania Sta. Rpt. 1899, p. 104.

[c] Illinois Sta. Bul. 50.

# SOME IMPORTANT FOREIGN VETERINARY INVESTIGATIONS.

By E. V. WILCOX, Ph. D., *Office of Experiment Stations.*

On account of the crowded condition of the population in the greater part of Europe and the necessity of preventing by all possible means losses which may naturally occur in the national economy of different States, the value of domestic animals is very high and the necessity of a thorough understanding of their diseases correspondingly imperative. A large number of investigators of first rank have for years devoted their energies to a solution of the most important veterinary problems, and their efforts have been supported by liberal governmental aid. Recruits for the army of veterinary investigators are being constantly furnished by a large number of trained men, who are annually graduated from veterinary schools. The present article will be confined to a general account of some of the more important results obtained by these investigators in the study of certain animal diseases. Foreign investigators along veterinary lines have given attention to all phases of the problem of preventing animal diseases, but not all of the results thus obtained are equally available for use in the United States. It may be stated as a general rule, however, that the more important animal diseases are almost world-wide in their distribution, and that no country is absolutely safe from infection by these diseases, particularly in view of the facilities which mutual commercial relations offer for the spread of animal plagues.

## TUBERCULOSIS.

Among the various diseases which afflict animal life there is none of such transcendent importance as tuberculosis, both from the standpoint of the losses which it causes to animal industry and also from that of the danger to human health. More time has been devoted, especially in recent years, to the study of this disease than to any other animal disease. Tuberculosis may attack all of the domesticated animals as well as man, and it is, therefore, of more general concern to the human race than the diseases which affect only the lower animals. Although considerable difference of opinion had been held concerning the nature of tuberculosis, a general agreement regarding the identity of tuberculosis in animals and man had been reached and prevailed until Koch's announcement before the British Medical Congress of 1901. At this congress, as is generally well known, Professor Koch stated his opinion, based on a number of experiments which he and his pupils had carried out, that there are two essentially different forms of tuberculosis, one of which affects man and the other the common domesticated animals. Koch also asserted, as corollaries of this proposition, that the human tubercle bacillus could not be transformed into that which affects cattle, and vice versa. It was, therefore, argued that the presence of tuberculous human attendants constitutes no serious danger to cattle or other domesticated animals, and that no further precautions need be taken regarding the use of the meat and milk of tuberculous cattle. This announcement of Professor Koch's was immediately contradicted by those who were present at the meeting, and has been subsequently combated in an ever-increasing number of articles reporting investigations concerning the identity of human and bovine tuberculosis. As a rule, the evidence obtained by these investigations in Europe has been opposed to the assertions of Professor Koch. Numerous experiments, carried out under the most careful observation of all necessary precautions, have shown beyond question that in a certain percentage of cases the tubercle bacilli obtained from human patients may cause a generalized and even fatal form of tuberculosis when inoculated into small laboratory animals or into large domesticated animals. For some time, therefore, it has been quite generally assumed as demonstrated that there is but one form of tuberculosis affecting man and the higher animals.

Quite recently, however, announcement has been made from several sources that there may be two forms of tuberculosis, man being susceptible to both forms. Evidence has been presented to show that apparently the two forms of tuberculosis may coexist in the human patient or in one of the domesticated animals. Dr. Nathan Raw,[a] on the basis of numerous post-mortem examinations of children affected with tuberculosis, came to the conclusion that the ordinary pulmonary form of tuberculosis affects primarily the lungs and is due to infection with bacilli of human origin. In other words, the lung form of tuberculosis in man is considered by Doctor Raw as due to infection from other tuberculous human patients and not from animals. The various forms of tuberculosis which appear in the intestines and other internal organs intimately connected with the intestines are apparently of a different nature, and the bacilli obtained from affected parts differ in many respects from those obtained directly from tuberculous lungs in human patients. A study of the differences observed in the bacilli obtained from the lungs and from the intestines of tuberculous human beings thoroughly convinced Doctor Raw that these were distinct species of bacilli, not capable of being transformed into each other. It was announced, therefore, as already stated, that there are two forms of tuberculosis, to both of which man seems to be readily susceptible.

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[a] British Med. Jour., 1903, No. 2226, pp. 470–474; 1904, No. 2265, pp. 1245, 1246.

Essentially the same results have quite recently been obtained, according to a preliminary statement by the German Imperial Tuberculosis Commission.[a] On the basis of extensive experiments, it was announced by this commission that two essentially different forms of tuberculosis must be recognized, one of which is characterized as human tuberculosis and normally affects the lungs of man, while the other, or bovine tuberculosis, is represented by the various forms of tuberculosis in cattle and intestinal tuberculosis in man. The intense interest which has existed for several years in the solution of the problem of the unity or duality of tuberculosis is considerably increased by these announcements affirming essential differences between human and bovine tuberculosis. Although according to this view, which appears to rest upon a firm basis at present, one of the essential contentions of Professor Koch is corroborated, the other, and from a sanitary standpoint the more important one, must fall to the ground. Reference is had here to Koch's assertion that on account of the non-identity of human and bovine tuberculosis no care need be exercised regarding the treatment of meat and milk of tuberculous cattle. The most recent investigations referred to, however, indicate clearly that while there are two different forms of tuberculosis, man is nevertheless susceptible to both, and it is therefore necessary that care be exercised to exclude tuberculous products from the market.

During the past five years more time has perhaps been devoted to the solution of this problem in the study of tuberculosis than to any other phase of the subject. Next in importance, however, in the aspects of the tuberculosis question comes that of the prevention of the disease. Along the line of prevention the greatest strides have been made in the methods of vaccination. The methods thus far proposed have yielded quite satisfactory results and have incidentally led to various controversies regarding priority in their discovery. The question of priority can not be discussed in this connection. Reference may be made briefly to some of the more important results which have been announced in Europe as a result of the studies in the prevention of the disease. Professor von Behring[b] published a preliminary statement of his method of immunizing cattle against tuberculosis in 1902. The method is called jennerization on account of its resemblance in essential details to the method of preventing smallpox in man. Von Behring found, as most other investigators had done, that different cultures of tubercle bacilli from man and from animals differ greatly in their virulence. It was demonstrated by laboratory experiments that the virulence of these races of bacilli could be greatly increased by the proper treatment and that likewise it could be attenuated by subjecting the bacilli to unfavorable conditions. During these experiments it was found that human bacilli when maintained in artificial cultures for many generations in the laboratory finally lost their virulence to such an extent that when inoculated into cattle they produced only a mild form of tuberculosis from which the inoculated animals subsequently recover. An examination of the lungs of cattle killed at varying periods after such inoculation showed that the process of the healing of the tubercles in the lungs was slow, but that ultimately the process became complete, at which time no bacilli could be found in the old tubercles. Some of the cattle kept at the Marburg University for experimental purposes were inoculated with these cultures of weak virulence for a number of times, and it was observed that the intensity of the reaction which followed these inoculations gradually diminished. After a number of such inoculations, the treated cattle were inoculated with very virulent cultures of tubercle bacilli obtained from cattle. The bacilli used in the first experiment of Von Behring had been so increased in their virulence that they produced death of untreated cattle within two weeks after inoculation. It was found, however, that the cattle which had been previously inoculated with human tubercle bacilli and had recovered from such inoculation were quite immune to the disease. No fatal cases of tuberculosis were developed among such animals. In most instances a mild form of the disease was caused, resulting in a slight elevation of temperature and some coughing for a few months, after which, however, the symptoms of tuberculosis disappeared. Such animals when killed and examined showed evidence of tubercles in the lungs, but such tubercles were healed and the bacilli contained in them were entirely disintegrated within a comparatively short time.

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[a] British Med. Jour., 1904, No. 2293, pp. 1596, 1597.

[b] Beitr. Expt. Ther., 1902, No. 5, p. 1-90.

The method proposed by von Behring has been tested quite extensively at the Marburg University and among the neighboring herds. The results announced in the preliminary statement have been confirmed, and the latest statement made by Doctor Römer,[a] one of von Behring's associates, is to the effect that the principle underlying von Behring's method of immunization has been definitely established after giving satisfactory results in more than 1,000 cattle. The investigators at the Marburg University state that in the future they will give more attention to the solution of the problem of rendering this method most practicable for ordinary veterinarians and cattle raisers.

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[a] Beitr. Expt. Ther., 1903, No. 6, pp. 1-110; No. 7, pp. 73-109.

A number of other investigators have worked along the same line in producing immunity toward tuberculosis and have obtained such satisfactory results that this method must be considered as a promising one in the control of the disease. The work of Arloing in France and McFadyean in England has shown that cattle may be successfully immunized against tuberculosis by previous treatment with human tubercle bacilli of slight virulence. Doctor Baumgarten[a] has been working on this method of immunization since 1902, and has shown that by the use of human tubercle bacilli cattle may be completely immunized against cultures of bovine tubercle bacilli which were fatal for animals which had not been previously treated. This author has had cattle thus treated under observation for a period of two and a half years. During this time no diminution in immunity to the disease has taken place. Baumgarten found that immunity in cattle could be produced by a single treatment with human tubercle bacilli. He argues, therefore, that it is unnecessary to make repeated intravenous inoculation, as has been recommended by von Behring and others, since this method requires more elaborate apparatus and time and produces more serious disturbances in the vaccinated cattle without increasing the intensity of immunity. In the experiments carried on by Baumgarten, human tubercle bacilli when inoculated subcutaneously into cattle produced no local infection and did not remain demonstrable at the point of inoculation, except for a short time. The result of vaccination is therefore considered not strictly a mild infection with tuberculosis, but more in the nature of an inflammatory process due to the toxic effect of the bacilli. Human tubercle bacilli, therefore, appear to operate as a vaccine toward bovine tuberculosis. According to Baumgarten's investigation the serum obtained from animals which had been immunized by his method contained no immunizing property and did not protect other animals when injected into them.

Various authors have called attention to the slow progress of tuberculosis under certain conditions, and the suggestion has been made that this may be due to a spontaneous vaccination which takes place during the course of the disease. Wahlen[b] found in his experiments that if guinea pigs were inoculated with mildly virulent tubercle bacilli of human origin there followed a mild outbreak of the disease of short duration, after which a considerable period of comparative inactivity of the tubercle bacilli was observed. As a rule, however, the disease again persisted in its course of generalization after the lapse of this interval. Wahlen believes that during the period of inactivity of the tubercle bacillus a natural process of vaccination is manifesting itself, but that under ordinary conditions this is not sufficient to protect the animal from further development of the disease.

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[a] Berlin. Klin. Wchnschr., 41 (1904), No. 43, pp. 1124, 1125.

[b] Compt. Rend. Soc. Biol. [Paris], 56 (1904), No. 2, p. 63.

Certain authors have raised the objection to the method of von Behring that the tubercle bacilli used for vaccination cause too serious disturbances in the vaccinated animals and remain alive for too long a period. An attempt has been made, therefore, to find tubercle bacilli of still lower virulence which would nevertheless produce immunity toward virulent cultures. Friedmann[a] carried on experiments with tubercle bacilli obtained from turtles, and has come to the conclusion that these bacilli fulfill all the required conditions in producing immunity toward tuberculosis and in causing the slightest possible disturbances and lesions which are compatible with the production of immunity in the treated animals. Tubercle bacilli obtained from turtles were of considerably lower virulence than human tubercle bacilli and caused no demonstrable lesion in the vaccinated animal. They had the power, however, of producing immunity in the small laboratory animals and in cattle toward the most virulent tubercle bacilli of bovine origin. Experiments have been carried out for the purpose of determining whether it is not possible to obtain the vaccinating effect from dead tubercle bacilli, and thus to avoid all possibility of infecting cattle by vaccination. Neufeld[b] conducted a number of experiments along this line, basing his experiments on the assumption of nonidentity of human and bovine tuberculosis. His general plan of immunization consisted in the use of dead tubercle bacilli for the first vaccination, following this treatment with gradually increasing doses of living bacilli, first of human origin and later of bovine origin. By this method Neufeld succeeded in immunizing six goats against infection with virulent tubercle bacilli. Similarly satisfactory results were also obtained in experiments on cattle and asses. An immunity was brought about by this method which enabled animals to resist successfully the most virulent bacilli. Friedmann succeeded in immunizing guinea pigs toward human tubercle bacilli by a previous treatment with bacilli obtained from turtles. It thus appears to be satisfactorily demonstrated that an immunity may be brought about in a majority of animals by a preliminary treatment with tubercle bacilli of very low virulence.

Another method for producing immunity has been worked out with considerable success by several European authors. Since 1895 Professor Maragliano[c] has conducted experiments in the immunization of animals toward tuberculosis by means of serum and bacilli of low virulence. Serum treatment of tuberculosis has given varying results in the hands of different authors, but according to Maragliano the method merits a more extended trial. Maragliano claims that he has produced immunity in cows, horses, asses, goats, sheep, and dogs, and that this immunity has persisted for a period of five years since the beginning of treatment. This author even succeeded in immunizing rabbits to tuberculosis by means of a preliminary inoculation with tubercle bacilli of low virulence. He found also that it is not necessary to make an intravenous inoculation. Equally satisfactory results were obtained when bacilli of low virulence were injected under the skin. All of these authors have suggested the possibility of extending this method of treatment to man. The danger, however, of reversing the order of procedure and inoculating human patients with tubercle bacilli of bovine origin is apparent from the fact that bovine tubercle bacilli are usually more virulent that those obtained from other sources, and their virulence may become increased by inoculation into human beings.

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[a] Deut. Med. Wchnschr., 30 (1904), No. 46, pp. 1673–1675.

[b] Deut. Med. Wchnschr., 29 (1903), No. 37, pp. 653–656.

[c] Berlin. Klin. Wchnschr., 40 (1903), Nos. 25, pp. 563–567; 26, pp. 593–596.

It was found by Wahlen [a] that tubercle bacilli which are capable of producing a spontaneously vaccinating tuberculosis in animals when cultivated outside of the animal body developed a vaccinating property in the culture medium. The specific action of filtered cultures from which all bacilli are removed varies extremely according to the origin of the cultures and the nature of the filters. Wahlen found that it was possible to obtain cultures of tubercle bacilli which did not produce any alteration at the point of inoculation even after a period of one month.

Much attention has been given by various European authors to the possibility of the transmission of immunity to offspring either through the blood during the organic union of the fetus and the mother or later by means of vaccinating properties in the milk of tuberculous animals. While such experiments have yielded results which are exceedingly interesting from a scientific standpoint, they are not yet capable of immediate application in practice. Hawthorn [b] found in his experiments that guinea pigs inoculated with tubercle bacilli of varying virulence transmitted to their offspring a slight vaccinating or protective property in the blood serum. The serum of the offspring had fully as pronounced a power of this sort as was observed in the mother, and this property persisted for about six months, during which the author had the animal under observation. No actual tuberculous lesions were to be found in the offspring of tuberculous guinea pigs.

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[a] Compt. Rend. Soc. Biol. [Paris], 56 (1904), No. 4, pp. 156, 157.

[b] Compt. Rend. Soc. Biol. [Paris], 56 (1904), No. 3, pp. 127, 128.

Medicinal treatment of tuberculosis has been investigated by a large number of authors and various remedies have been suggested as showing considerable efficiency in this direction. Olive oil [a] has been used to some extent in the treatment of tuberculosis in man and the results obtained in a few instances indicate that a similar treatment might perhaps be adopted in animals with some hope of success. The use of cinnamon has not given very satisfactory results. Intensive feeding with muscle serum has shown that this substance has the power of so stimulating the nutritive process of tuberculous animals that they can resist the progress of tuberculosis much more successfully than would otherwise be possible. Recently Hoffmann [b] has tested the value of hetol in the treatment of tuberculosis. This author's experiments were made on guinea pigs and rabbits. Hetol has been used by various other authors for similar purposes. It was found during the numerous experiments which Hoffmann carried out that animals which had been previously treated with hetol withstood infection much longer and more successfully than other animals which had not received hetol. The tubercles produced in treated and untreated animals were carefully studied and were found to show certain essential differences. In the animals which had been treated with hetol the tubercles were small and sharply differentiated from the surrounding tissue and were surrounded by white blood corpuscles. The giant cells which were characteristic of actively developing tubercles were small or entirely absent. Hoffmann concludes from his experiments that considerable importance is to be attributed to hetol in curing tuberculosis. This drug apparently has the power of materially assisting the organism in limiting the tuberculous processes and bringing about a final healing of the tubercles which have already been formed.

Many investigators have studied the effect of tuberculosis upon the red blood corpuscles. Humbert has shown quite conclusively that the blood corpuscles lose a part of their power of resistance during the progress of the disease and are considerably diminished in number. It is desirable, in many instances, to make a rapid diagnosis in suspected cases of tuberculosis, and experiments by Marmorek, Nattan-Larrier, and others have shown that a tuberculin reaction may be obtained within three hours after inoculating small laboratory animals. It thus becomes possible to secure fluids from suspected cases and use them for inoculation with laboratory animals, after which a diagnosis may be expected within a few hours.

A great deal of attention has been devoted to the study of the milk of tuberculous cows for the purpose of determining the relative frequency of the occurrence of tubercle bacilli in it. The importance of this problem is readily recognized if we consider the possibility of tuberculous milk being mixed with healthy milk in city milk supplies, and under other conditions, and also the use of such milk in feeding calves, pigs, and other farm animals. It has been shown conclusively that the milk of tuberculous cows may contain tubercle bacilli although no actual lesions are demonstrable in the udder. In a series of experiments carried out by Moussu, 7 out of 57 samples of milk taken from tuberculous cows, in which no physical symptoms of the disease were present, contained tubercle bacilli in a virulent form. It is thus apparent that while in a great majority of cases the milk does not contain tubercle bacilli, these organisms may be present at any moment, and the milk of tuberculous cows can, therefore, not be considered safe under any conditions. Ostertag also made an elaborate study of this phase of the problem for the purpose of determining whether tubercle bacilli could be readily detected in milk by means of bacteriological examinations. During this study it was found that tuberculosis of the udder was characterized by painless swellings without any higher temperature than that shown by the surrounding tissue. In advanced cases of tuberculosis of the udder it was found that the milk from affected quarters of the udder may be virulent in a dilution of 1:1,000,000 parts. In general the meat of tuberculous animals has been shown by careful investigation to be comparatively free from tubercle bacilli even in acute cases of generalized tuberculosis. Even in cases in which the lymphatic glands, lungs, and other vital organs are thoroughly permeated with active tubercles in the process of growth the meat may be quite free from tubercle bacilli. In rare cases, however, the meat may contain virulent bacilli, at least for short periods, during active eruption of tubercles. Such results have recently been obtained by Westenhoeffer[a] in Berlin.

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[a] Vet. Jour., 59 (1904), No. 13, pp. 606–608.

[b] Arch. Wiss. u. Prakt. Tierh., 30 (1904), No. 1–2, pp. 162–187.

### RABIES.

One of the most important problems in connection with the study of rabies, or hydrophobia, is to devise a rapid and certain method of diagnosis, so that the nature of the disease in suspected dogs may be readily determined. Numerous alterations in the nervous system or other structures have been claimed by different investigators as characteristic of rabies. The close resemblance, however, between these alterations and those due to other diseases leaves some doubt in the minds of most scientists concerning the value of such alterations in forming a diagnosis. Babes[a] described certain leisons which he considered to be constant in the nervous system in cases of rabies. Microscopic changes were observed in the gray matter surrounding the canal in the brain and spinal column and in the motor centers of the medulla oblongata and spinal cord. In addition to a great multiplication of small nuclei in the cells of this tissue, Babes recently concluded that certain changes in the minute structure of the nerve cells of the central nervous system could be depended upon in the diagnosis of rabies. Golgi based his system of diagnosing rabies upon the formation of vacuoles in the nerve cells, changes in the nerve ganglia between the vertebræ, and other related alterations. Van Gehuchten and Nélis claimed to be able to diagnose rabies by means of certain changes in the peripheral ganglia of the spinal and sympathetic nervous systems, especially in the so-called plexiform ganglia of the vagus nerve and the gasserian ganglia. The ganglion cell is greatly modified as the result of the multiplication of the cells lining the endothelial capsule, and it is finally quite destroyed. Gilruth,[b] however, in his investigations of rabies found the changes referred to by Babes and Golgi to be quite unreliable. The lesions claimed as diagnostic by Van Gehuchten and Nélis were of considerable value in diagnosing the disease. Hebrant'[c] found the changes in the gasserian ganglia to be characteristic of rabies. The ganglion of the left side was more acutely attacked than that of the right. Rabieaux[d] believes, as a result of his investigations of rabies, that lesions in the plexiform ganglia may be depended upon in the diagnosis of the disease. The same author found that the presence of grape sugar in the urine is a very frequent symptom of rabies, which, taken in connection with the alterations in the nervous system, furnishes a basis for a certain diagnosis. Byelitzer[e] made an extensive study of rabies, giving particular attention to diagnosis according to the method of Nélis. The characteristic alterations in the nervous system are believed by this author to be less constant in horses, cattle, sheep, and hogs which have died of rabies than in dogs. While the method of Nélis, according to this author, may fail to give satisfactory results in all cases, it is believed that all positive results obtained by the method may be confidently relied upon. Quite recently Rabieaux has come to the conclusion that a reliable diagnosis of rabies can not always be reached by a microscopic examination. Bosc[f] has called attention to the fact that the lesions in the nervous system caused by rabies virus are almost identical, in detail and as a whole, with those of sheep pox. Negri,[a] on the basis of his study of rabies, has announced the discovery of a protozoan organism which, he claims, can be detected in nearly all cases of rabies and which is, therefore, claimed to be the cause of the disease. Beck[b] found the organism of Negri in 47 out of 72 cases of rabies which he studied. Negri claims that the organism in question occurs exclusively in the nerve cells of rabid animals and sometimes in a certain portion of the brain only.

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[a] Ueber die Grenzen der Uebertragbarkeit der Tuberculose durch Fleisch tuberculöser Rinder auf den Menschen. Berlin, 1904.

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[a] Centbl. Bakt. u. Par. 1. Abt., 27 (1900), Nos. 16, 17, pp. 464–468.

[b] Veterinarian, 73 (1900), No. 870, pp. 315–319.

[c] Ann. Méd. Vét., 49 (1900), No. 6, pp. 302–309.

[d] Jour. Méd. Vét. et Zootech., 5. ser., 6 (1902), Jan., pp. 16–28.

[e] Arch. Vet. Nauk, St. Petersburg, 33 (1903), Nos. 4, pp. 347–382; 5, pp. 463–492.

[f] Compt. Rend. Soc. Biol. [Paris], 55 (1903), No. 31, pp. 1284–1286.

The organism described by Negri, however, has not been identified by all the investigators who have worked on the subject of rabies. Remlinger[c] carried out a number of experiments during which it was found that the pathogenic organism of rabies, whatever it may be, must be ultramicroscopic in size since it passes through fine filters. It is believed, therefore, that Negri's corpuscles can not be considered as the cause of the disease. Bertarelli[d] studied the relation between modifications of the virulence of rabies virus and alterations in Negri's corpuscles. It was found that these corpuscles are not much affected even by extreme changes in the virulence of the rabies virus. This author is, therefore, in doubt whether the corpuscles should be considered as protozoan organisms or as pathological structures containing such organisms.

The resistance of rabies virus to putrefaction has been studied by von Ratz[e] and other authors and it has been found that the virus may resist the action of putrefaction for a long time but that its virulence is gradually modified. The results of inoculation experiments indicate that the virus was still present in a rather virulent form in the brain of dogs which had been buried from 14 to 24 days. Ouchakoff[f] and other authors have studied the attention of rabies virus by means of heat. During these experiments it was shown that virus was destroyed at a temperature between 50 and 60° C. When the virus was subjected to a temperature of 52° for a half hour, it was only slightly attenuated; a temperature of 53°, however, for ten minutes greatly attenuated or completely destroyed the virus.

A great amount of attention has been given to a study of the methods of treating and preventing the development of rabies. Aujeszky[g] found that hypodermic injections of emulsions of normal nerve tissue are not sufficient to protect animals against rabies virus. In some experiments the methods seemed to be successful, but in such cases the virulence of rabies virus was not carefully determined and it is possible that it was not strong enough to produce the disease. Rodet[a] and other authors employed, in the treatment of rabies, a serum obtained from sheep which had been treated with rabies virus. This serum, when inoculated under the skin, directly into the circulation or into the body cavity, proved to be without effect except after the use of rabies virus. When injected into the brain it had the effect of prolonging the disease, but its influence in all cases was comparatively slight. Krasmitski,[b] by means of an extensive series of experiments, found that intravenous injections of rabies virus are not particularly dangerous, provided the virus is administered in a filtered and diluted form after a previous subjection to a temperature of 37° C. By means of the injection of such virus it was found possible to render animals refractory to rabies in a very short time, and the immunity thus produced appeared to be more lasting and certain than that produced by other methods of vaccination. Intravenous injections in rabbits sometimes prevented the development of the disease even after inoculation of virulent rabies virus directly into the brain. Conte[c] had little success in treating horses for rabies by means of intravenous injections of material obtained from rabid dogs. A test of the method was made on five animals, beginning within from three to six days after the animals were bitten; four of the animals, however, ultimately died with the usual symptoms of rabies. Beck has called attention to the fact that in doubtful cases the inoculation of rabbits may serve to yield a rapid, differential diagnosis between rabies and dog distemper. While rabbits are susceptible to both diseases it is impossible to reproduce dog distemper by inoculation of other animals with the brain of affected rabbits.

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[a] Ztschr. Hyg. u. Infectionskrank., 43 (1903), No. 3, pp. 507–528; 44 (1903), No. 5, pp. 519–540.

[b] Fortschr. Vet. Hyg., 1 (1903), No. 9, pp. 253, 254.

[c] Ann. Inst. Pasteur, 17 (1903), No. 12, pp. 834–849.

[d] Centbl. Bakt. u. Par., 1. Abt., Orig., 36 (1904), No. 1, pp. 42–51.

[e] Centbl. Bakt. u. Par., 1. Abt., 27 (1900), No. 24, pp. 825–828.

[f] Arch. Sci. Biol. [St. Petersburg], 8 (1900), No. 2, pp. 131–135.

[g] Centbl. Bakt. u. Par., 1. Abt., Orig., 32 (1902), No. 5, pp. 353–357.

In 1903[d] Sime published a book on the general subject of rabies. In this volume a theory regarding the intensification and attenuation of rabies virus is proposed. Animals which are susceptible to rabies are classified under two groups, called intensifiers and attenuators, respectively. According to Sime herbivorous animals, particularly rabbits, intensify the virulence of rabies virus, while carnivorus animals, particularly man, monkeys, and dogs, attenuate the virus. Statistics are presented to prove that the disease prevails most extensively in regions where rabbits are most numerous, and that rabies is unknown in countries where there are no rabbits. This theory, however, has not been substantiated by other observers.

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[a] Compt. Rend. Soc. Biol. [Paris], 52 (1900), No. 40, pp. 1091-1093.

[b] Ann. Inst. Pasteur, 16 (1902), No. 6, pp. 393-417.

[c] Rev. Vet. Toulouse, 27 (1902), No. 7, pp. 434-442.

[d] Cambridge, Eng., University Press, 1903, pp. XII+290.

## TETANUS.

Among the great number of investigations which have been reported on tetanus in foreign countries a large proportion has been occupied with the treatment of the disease and with the course of infection. Numerous experiments have been made for the purpose of testing the value of serum treatment for tetanus. The results obtained by such studies, while not uniform, still furnish a basis for reasonable hope of ultimate control of tetanus by this means. Ransom[a] made quite an extensive study of tetanus for the purpose of determining the agency of the lymph in distributing the toxin and the antitoxin of the disease throughout the affected animal. In the experiments carried out by this author dogs were utilized, since the thoracic duct in these animals could be readily exposed and the lymph allowed to flow out into receptacles through a cannula inserted into the duct. Before being operated upon the dogs were treated with morphin and anæsthetized. They were kept in this condition during the experimental period. Blood from the same animals was taken from the femoral artery. In order to determine the strength of the toxin and antitoxin as found in the lymph and blood inoculations tests were made with mice. It was found that after the tetanus toxin was injected into the circulating blood a considerable portion of it rapidly passed into the lymph. If the blood and lymph systems are left as nearly as possible in their natural condition the toxin is found equally distributed in the blood and lymph twenty-six hours after injection. If the thoracic duct is opened shortly before the animal receives an intravenous injection, the toxin content of the blood remains considerably greater than that of the lymph for six hours after injection. When horse serum containing tetanus antitoxin is injected into the blood this substance rapidly finds its way into the lymph. No noteworthy changes were found to take place in the toxin or antitoxin while remaining in the blood or lymph.

Marchal[b] treated horses for tetanus quite successfully by means of antitetanus serum. At first 50 cubic centimeters of the serum was given by the hypodermic method. The injection was repeated in similar doses. Various other drugs, such as chloral hydrate, bromid of potash, and morphin were administered. In some cases recovery took place within twenty-three days after the appearance of the symptoms. No irritation was caused by the antitetanus serum at the point of inoculation. Debrand[c] found during a study of the methods of cultivating the bacillus of tetanus that when this organism was mixed with the hay bacillus the tetanus bacillus developed readily, even in the presence of air. The serum obtained by treating animals with bacilli grown in symbiosis with the hay bacillus proved to be as active as that obtained by the ordinary methods of cultivating the tetanus bacillus. In some instances the use of antitetanus serum given in ernormous doses, combined with treatment by means of carbolic acid, chloral hydrate, and morphin failed entirely to check the development of the violent symptoms of tetanus. Irrigation of the body cavity with a physiological salt solution was found by Tonzig[a] to be entirely without effect on the course of tetanus. This is attributed to the fact that the tetanus virus does not remain free in the circulation, but becomes fixed in the histological elements of the nervous tissue.

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[a] Ztschr. Physiol. Chem., 29 (1900), No. 4–5, pp. 349–372.

[b] Rec. Méd. Vét., Paris, 8. ser., 9 (1902), No. 1, pp. 16–20.

[c] Ann. Inst. Pasteur, 16 (1902), No. 6, pp. 427–432.

Fiebiger[b] found in his experiments that the mortality from tetanus could be much reduced by treatment with emulsions of brain substance. The results of this treatment appeared to be quite as satisfactory as those obtained by other known treatments. The treatment with brain emulsion is cheaper than serum therapy, and Fiebiger believes that the technique is not too complicated for the ordinary practicing veterinarian. A large number of authors, including Dmitrievski,[c] Marx,[d] Besredka,[e] and others, have found that the toxin or virus of tetanus is fixed by the substances of the central nervous system. Apparently the brain substance is capable of fixing more tetanus toxin and preventing it from being further distributed than it can neutralize. The fixative property of the brain toward tetanus toxin is therefore not identical with the antitoxic power. The brain substance when saturated with tetanus toxin completely recovers its integrity after the addition of tetanus antitoxin, whether it is obtained from an animal of the same or a different species. The combination of the brain substance and the tetanus toxin does not give a substance as stable as that obtained by a mixture of toxin and true antitoxin. Marx found that the brain substance cooperates with antitoxin in neutralizing the tetanus toxin. The functional value of the brain substance and antitoxin is considered by these authors to be about equal. Dmitrievski found during his exhaustive study of this subject that the brain of animals which have enjoyed an immunity toward tetanus of short duration, as well as their blood, does not possess any great power of counteracting the development of the disease and does not differ much in this respect from the normal brain. The brain and blood of animals which have been immunized for a long time, however, appear to contain a large quantity of antitoxin and are capable of neutralizing a much larger quantity of tetanus toxin than the brain of normal animals. The difference, however, is not very great, since all animals which were injected with a mixture of toxin and brain substance presented certain symptoms of tetanus. It was found by Dmitrievski that the blood of animals which have enjoyed a long immunity toward tetanus always contains more antitoxin than the brain.

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[a] Pub. Ist. Univ. Padova, 2 (1902), VI, pp. 11; extr. from Riforma Med., 17 (1901), No. 109.

[b] Ztschr. Thiermed., 6 (1902), No. 3, pp. 161–170.

[c] Ann. Inst. Pasteur, 18 (1903), No. 2, pp. 148–160.

[d] Ztschr. Hyg. u. Infectionskrank., 40 (1902), No. 2, pp. 231–238.

[e] Ann. Inst. Pasteur, 17 (1903), No. 2, pp. 138–147.

During experiments carried out by Calmette[a] it was found that guinea pigs could easily be immunized against tetanus by causing the absorption of small quantities of antitetanus serum in wounds of the skin. Good results were not usually obtained, however, from rubbing the wound with a brush dipped in the liquid serum. Positive results were almost always obtained when a small quantity of finely pulverized or dry serum was sprinkled in the wound. Experiments were conducted by the same author for the purpose of testing the action of dry antitetanus serum when placed in the wound with living tetanus bacilli. In a test during which 10 guinea pigs were inoculated and not treated and 10 others inoculated and treated as just indicated with dry antitetanus serum the latter 10 animals failed to develop tetanus, while all of the untreated animals died after the disease had run its usual course. Ignatowsky[b] in a study of tetanus found that no special substance was produced in any of the organs of the body which might account for a reaction toward tetanus toxin. The brain, spinal cord, liver, kidney, spleen, lung, and muscle tissue of rabbits and guinea pigs dead of tetanus when inoculated into mice were found to be capable of transmitting the disease. The symptoms in such cases are quite different from those usually observed. The bile was found not to contain tetanus toxin under normal conditions. The various organs of the body, however, appear to be capable of fixing or neutralizing the tetanus toxin to some extent.

Marie[c] made a study of the course taken by the tetanus virus in passing from the periphery to the central nervous structures. It was shown that the tetanus toxin is absorbed by the terminal portions of the motor nerves, and that a small quantity of the toxin placed in contact with these nerves is sufficient to produce tetanus even in animals which have received a sufficient quantity of antitoxin to render them immune to inoculations with toxin by the hypodermic or intravenous methods. According to Marie, tetanus toxin is always found in the nerves in inoculated animals. This author argues that the toxin does not penetrate from the periphery to the central nervous system in the lymphatic space around the nerve, but rather in the nerve substance and especially in the axis cylinder of the nerve. Meyer and Ransom[a] believe that they have demonstrated that the transportation of the toxin to the central nervous system takes place only by way of the motor nerves. During the experiments carried out by these authors it was shown that the progress of the toxin along the motor nerves could be checked by an application of antitoxin to the nerve cords. That the course of the toxin is centripetal along the motor nerve was shown by experiments to determine the period of incubation of tetanus from infection by different methods. The characteristic rigidity of the muscles in cases of tetanus is believed to be due to the action of the toxin on the nerve centers.

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[a] Compt. Rend. Acad. Sci. [Paris], 136 (1903), No. 19, pp. 1150–1152.

[b] Centbl. Bakt. u. Par., 1. Abt., Orig., 35 (1903), Nos. 1, pp. 4–14; 2, pp. 158–168.

[c] Bul. Inst. Pasteur, 1 (1903). No. 17, pp. 633–640.

The elaborate experiments of von Behring[b] in the study of tetanus have shown that the relative amount of antitoxin required for the neutralization of toxin decreases with the increase in the quantity of toxin. This fact is considered somewhat remarkable when it is remembered that the exact reverse is true for diphtheria. Von Behring believes that nothing is added to or taken from the toxin molecules when they become attenuated. It is claimed that they suffer merely a diminution in the rapidity of their reaction without any material change. Rabbits were most successfuly immunized by means of attenuated tetanus toxin obtained from the central nervous system. The immunizing power of such attenuated toxin appears to be determined by several factors, chiefly, however, by any influence which may favor or hinder the penetration or absorption of the toxin by the nervous system. Vincent found in a study of tetanus in guinea pigs that heat exercised considerable influence upon the development of tetanus. The subjection of these animals to high degrees of temperature was found to cause numerical changes in the relative proportions of different kinds of white blood corpuscles and a corresponding diminution in the resisting power of such animals toward tetanus bacillus. Garnier[c] made a study of the effects of various micro-organisms upon the tetanus toxin. Particular attention was given to the effect of anthrax bacilli upon this toxin. It was found that tetanus toxin, in which anthrax bacilli were cultivated, became greatly attenuated after a period of twelve to fourteen days. The loss of the specific power of the toxin, however, was not accompanied with a loss of its injurious effects.

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[a] Proc. Roy. Soc. [London], 72 (1903), No. 477, pp. 26–30.

[b] Beitr. Expt. Ther., 1904, No. 7, pp. 1–72.

[c] Compt. Rend. Soc. Biol. [Paris], 57 (1904), No. 27, pp. 203, 204.

In addition to the usual method of treating tetanus by means of serum, successful results have been announced in a few cases by methods in which this treatment was entirely omitted. Bergeon[a] has successfully treated a few cases of tetanus by the expectant method, during which the symptoms were combated by appropriate remedies, as occasion required. Kissuth[b] claims to have cured two cases of undoubted tetanus by means of fright produced by firing a gun in the stalls in which the affected horses stood. The gun was fired at the time when the muscular contraction was at its height, and had the effect of producing a complete muscular relaxation, after which the animals were able to eat and drink without much difficulty. One case recovered after a period of fourteen days, while recovery in the other case was slower. Grams[c] reports that he has treated thirty-five cases of tetanus by means of sodium iodid. As a rule this remedy was administered through the trachea in doses of 5 grams in solution. The drug may also be administered intravenously or by way of the mouth. The quantity of sodium iodid to be used is not considered of primary importance, but good results were obtained by this author from the use of 2 or 3 grams dissolved in 10 grams of water, and administered immediately after infection and daily for two or three days thereafter. Quite recently Croce[d] has succeeded in curing a few cases of tetanus by means of subcutaneous injections of carbolic acid. In one case in a horse a cure was effected by four injections of 10 grams each of a mixture containing 1 gram carbolic acid for each 100 grams of glycerin. In a second case, with more alarming symptoms, much larger doses were given, with satisfactory results.

## ANTHRAX.

Although anthrax is one of the oldest infectious diseases concerning which definite information was had, much advance has recently been made in methods of treatment. The greater number of investigations reported within the past few years have been concerned with this phase of the problem. Yordal[e] attempted to treat anthrax by means of creolin. It was found, however, that the disease was not checked by doses of 25 grams. In experiments carried on by Calamida[f] it was found that in dogs, which are known to possess a high immunity toward anthrax, the injection of non-fatal doses of corrosive sublimate one-half hour before inoculation with anthrax bacilli produces death from anthrax infection. Similar injections of corrosive sublimate did not destroy the natural immunity in chickens. Experiments with digitalin showed that when this drug was injected after inoculation with anthrax and treatment with corrosive sublimate it counteracted the harmful influence of the corrosive sublimate.

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[a] Rev. Vét. Toulouse, 29 (1904), No. 11, pp. 737–739.

[b] Berlin. Tierärztl. Wchnschr., 1900, No. 45, p. 532.

[c] Berlin. Tierärztl. Wchnschr., 1903, No. 15, pp. 249–255.

[d] Clin. Vet., 27 (1904), No. 11, pp. 61–64.

[e] Berlin. Tierärztl. Wchnschr., 1900, No. 6, pp. 63, 64.

[f] Centbl. Bakt. u. Par., 1, Abt., Orig., 37 (1904), No. 1, pp. 11–18.

In experiments made by Danysz[a] for the purpose of determining the action of rat serum on the anthrax bacillus, it was found that the action of the diastase contained in rat serum was more noticeable in distilled water than in physiological salt solution. The first vaccine used in the treatment of anthrax was more sensitive to the rat serum than the second vaccine, and the latter in turn was more sensitive than virus. Very small quantities of serum seemed to favor the active growth of the bacillus. It was concluded from these experiments that rat serum does not contain a true bacteria-destroying diastase, but only a substance analogous to antiseptics. Rat serum, when deprived of its antiseptic constituent, was found to be a good medium for the growth of the anthrax bacillus. Sclavo[b] obtained satisfactory results with a curative anthrax serum in experiments on rabbits and sheep. From sheep a serum was obtained which completely protected rabbits against anthrax. Different sheep reacted differently to the preliminary treatment designed for the production of the curative serum. The difference in the strength of serum obtained did not depend on the age, breed, or sex of the sheep, but appeared to be a peculiarity of individual animals.

Pigeons and guinea pigs were successfully vaccinated against anthrax by De Nittis.[c] The vaccination of pigeons offers no special difficulty on account of the possession of a high natural immunity by these birds. Vaccination of guinea pigs was found to be a long and difficult operation. In these experiments two attenuated vaccines were used in obtaining the desired results, and immunity was brought about only after two or three months, during which many of the animals died despite all precautions. It was found that the serum of highly vaccinated guinea pigs is without action on mice and guinea pigs which have just been inoculated with anthrax. Vaerst[d] carried out a number of experiments with the enzym obtained from *Bacillus pyocyaneus*. Animals were inoculated simultaneously with this enzym and the anthrax bacillus. As a result of these experiments it was concluded that the enzym exercises not only a restraining influence upon the development of anthrax bacilli but may actually dissolve them. The simultaneous injection of the enzym with anthrax bacilli may check the development of the disease. Ortmann[a] succeeded in curing anthrax by the use of intravenous injections of colloidal silver combined with the administration of lysol, bicarbonate of soda, and gentian root. In extensive experiments with methods of vaccination for anthrax in Russia Gordzyalkovski[b] found that when proper care is exercised in vaccination perfectly satisfactory results may be obtained with horses and cattle. In these experiments two vaccines were used, and the second vaccine, administered in doses of 0.25 cubic centimeter, rendered the animal perfectly immune. Unsatisfactory results which had previously been obtained were explained as due to the use of too virulent cultures or improperly graduated doses. Sanfelice[c] inoculated dogs with attenuated cultures of anthrax bacilli, gradually increasing the virulence of the cultures which were used. In this way it was found possible to secure a serum from treated dogs which would protect animals against infection with virulent cultures of anthrax. In a similar series of experiments carried out by Bail[d] it was found that dog serum which had been shown to be perfectly inactive toward anthrax bacilli could be given very active properties by the addition of minute quantities of rabbit serum. The effect of rabbit serum was noticeable, even when added in the proportion of 1 to 1,000.

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[a] Ann. Inst. Pasteur, 14 (1900), No. 10, pp. 641–655.

[b] Berlin. Klin. Wchnschr., 38 (1901), No. 18, pp. 481–484.

[c] Ann. Inst. Pasteur, 15 (1901), No. 10, pp. 769–784.

[d] Centbl. Bakt. u. Par., 1. Abt., Orig., Nos. 7, pp. 293–317; 8, pp. 348–355.

Minder[e] treated anthrax in cattle by means of carbolic acid. A 0.5 per cent solution of carbolic acid in water was administered in frequent doses, so as to aggregate 40 to 50 liters during twenty-four hours. The condition of the affected cattle improved quite rapidly in all cases and recovery ultimately took place. Galtier[f] carried on experiments with rabbits and guinea pigs, during which it was found that the addition of iodin or Lugol's solution to a culture of anthrax bacilli at the time of inoculation was sufficient to prevent infection with the disease. Jürgelunas[g] obtained an immunizing serum from goats and sheep which were inoculated subcutaneously with the two anthrax vaccines at an interval of two weeks. This serum was found to be capable of protecting a certain proportion of guinea pigs against virulent cultures of anthrax bacilli. The serum also brought about a considerable degree of immunity to the disease. The method of Sobernheim, which consists in the use of an anthrax serum followed by an attenuated culture of the bacilli, has been tested extensively in Germany and elsewhere. In 1897 Sobernheim announced that he had succeeded in immunizing 8,000 sheep, among which number only eight died of anthrax. The method has been tried in the treatment of anthrax in cattle, horses, and other animals. Jaeger in his experiments showed that the therapeutic action of the serum obtained by Sobernheim depends almost entirely upon the method of inoculation. Subcutaneous inoculation, even in large doses, merely served to check the progress of the disease for a few days. Intravenous injection of serum, however, was almost always sufficient to save the life of even badly affected animals, and this method was found to be quite harmless. In experiments carried out by Strebel[a] it was found that considerable success could be expected in the prevention of the disease by the adoption of direct antisepsis and the use of vaccines. Carbolic acid was tested in intravenous injections without satisfactory results.

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[a] Berlin. Tierärztl. Wchnschr., 1902, No. 8, p. 125.

[b] Arch. Vet. Nauk, St. Petersburg, 32 (1902), No. 8, pp. 653-663.

[c] Centbl. Bakt. u. Par., 1. Abt., Orig., 33 (1902), No. 1, pp. 61–71.

[d] Centbl. Bakt. u. Par., 1. Abt., Orig., 33 (1903), No. 5, pp. 343–353.

[e] Schweiz. Arch. Tierh., 44 (1902), No. 6, pp. 267–271.

[f] Jour. Méd. Vét. et Zootech., 5. ser., 7 (1903), Aug., pp. 462–467.

[g] Ztschr. Hyg. u. Infectionskrank., 44 (1903), No. 2, pp. 273–280.

Gilruth[b] in a long series of experiments found that guinea pigs, rabbits, and sheep may exhibit a complete resistance to inoculation with large doses of virulent anthrax bacilli if these organisms are mixed with a larger quantity of another organism which is not pathogenic to the animals in question. The anthrax bacillus must be mixed with the other organism, for if they are injected simultaneously in different parts of the body no resistance is brought about. The immunity thus produced is somewhat temporary. The best results were obtained when Gaertner's bacillus was mixed with the anthrax bacillus. The same method was later found to be applicable to cattle, a considerable number of which were successfully treated in this way. In later experiments of the same author, however, guinea pigs did not appear to display any definite resistance to anthrax bacillus when treated by this method.

A thorough knowledge of the exact conditions under which spore formation takes place in the anthrax bacillus is of great importance in combating the disease. Klett[c] concluded from his experiments along this line that the formation of spores in the anthrax bacillus is not dependent upon the presence of oxygen. Anthrax bacilli were found to form spores abundantly in an atmosphere of nitrogen, but not in one of hydrogen. Weil[d] found that when material containing anthrax spores is subjected to favorable conditions for germination the majority of the spores germinate within a fairly constant period. It was impossible, however, to determine a time at which no spores were present in a material, and it appears impossible, therefore, to free such material from spores by the method of fractional sterilization. New spores are always formed before all of the old spores have germinated. The germination of the greater number of anthrax spores took place, as a rule, after eight, sixteen, and seventy hours at temperatures of 37°, 24°, and 18° C., respectively. The germination of anthrax spores was strongly influenced by weak solutions of various chemical reagents. A brief exposure to 1 per cent chloroform, 1.5 per cent carbolic acid, or a 1 per cent solution of formalin destroyed all of the spores. Eijkman [a] found that live steam under low pressure was more effective in destroying anthrax spores than was boiling water. The explanation of this difference in the effect of live steam and boiling water is believed to be found in the fact that the boiling point of water is raised by the presence of soluble materials, such as salt and sugar, while steam is not thereby influenced. The disinfection of the skins of animals affected with anthrax is an important problem of sanitation. Lignières [b] experimented with a number of antiseptic substances, such as crude carbolic acid, lysol, cresol, creolin, etc. Solutions of crude carbolic acid and 5 per cent solutions of the coal-tar products were sufficient to destroy the anthrax bacillus, but not the spores, when the skins were dipped in these solutions for a period of fifteen minutes. Live steam with which the fumes of formalin are mixed has been found to be very efficient in disinfecting skins. Many outbreaks of anthrax are due to eating infected food. Among such material oats have often been found to be infected. In experiments to determine the best method of destroying anthrax spores on oats it was found by Jaeger [c] that a dry heat of 180° to 200° C. for a few minutes was required to destroy these spores. For this purpose an apparatus such as commercially used for desiccating potatoes may be used. In experiments by the same author it was found that a temperature of 180° C. for a period of twelve minutes was sufficient to destroy anthrax spores in a layer of oats 2 centimeters deep. The oats, however, were considerably roasted by subjection to this temperature and were therefore greatly reduced in market value. By the use of Venuleth's apparatus it was found possible to subject the oats to a sufficiently high temperature to destroy the anthrax spores within twelve minutes without roasting the oats. The color of the oats was slightly darkened, but they were still marketable, and their nutritive value was not affected. In experiments with anthrax spores Selter [d] found that glycerin and grape sugar in 5 per cent and 2 per cent solutions, respectively, exercise a direct influence upon the development of spores. Nonspore-bearing races of anthrax bacilli were readily obtained by repeated transfers on culture media containing glycerin.

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[a] Schweiz. Arch. Tierh., 45 (1903), No. 3, pp. 105–113.

[b] New Zealand Dept. Agr., Div. Vet. Sci. Bul. 7.

[c] Ztschr. Hyg. u. Infectionskrank., 35 (1900), No. 3, pp. 420–438.

[d] Arch. Hyg., 39 (1901), No. 3, pp. 205–229.

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[a] Centbl. Bakt. u. Par., 1. Abt., Orig., 33 (1903), No. 7, pp. 567, 568.

[b] Rev. Gén. Méd. Vét., 1 (1903), No. 5, pp. 249–255.

[c] Monatsh. Prakt. Tierh., 16 (1904), No. 4–5, pp. 232–235.

[d] Centbl. Bakt. u. Par., 1. Abt., Orig., 37 (1904), Nos. 2, pp. 186–193; 3, pp. 381–389.

Considerable importance has been laid upon the variation of the susceptibility of different races of sheep to anthrax. Martinet carried out experiments along this line, during which he selected purebred merinos, merino crosses, and lambs from crosses of the second generation. Three of the four animals thus inoculated died of anthrax, but the power of resistance varied and indicated that this power is in inverse proportion to the amount of merino blood present in the animal. This author recommends the crossing of pure merinos with some other race in localities where anthrax is liable to cause losses.

## TEXAS FEVER.

Following upon the investigations of the Bureau of Animal Industry and experiment stations of this country foreign veterinarians have prosecuted studies on various phases of the Texas-fever problem. The disease has been identified in various countries, but is known under different names. In Argentina it is called tristeza; in Germany, hemoglobinuria; in Australia and South Africa, redwater or tick fever. It is generally admitted by investigators that the disease in all these countries is due to the same blood parasite, and that this parasite is carried from diseased or recovered animals to susceptible animals by means of ticks. Almost the only prominent investigator who doubts the agency of ticks in the transmission of the disease is Mégnin.[a] This author, in a recent article, argues at considerable length that the agency of ticks in transmitting Texas fever has not been proved, and contends that, in order to demonstrate this point, it is necessary to find the pathogenic organism of Texas fever in the adult ticks, eggs, larvæ, and nymphs. Bey,[b] in studying cases of Texas fever in Egypt, observed that during the first two hours after death the temperature of the carcass sometimes rose above 44° C. This post-mortem elevation of temperature is not thoroughly understood, but is a phenomenon comparable with similar occurrences in cases of Asiatic cholera in man.

The German imperial health office[c] made an extensive study of Texas fever or hemoglobinuria in Germany. It was found that, as a rule, the period of incubation of the disease in Germany is about fourteen days. In experiments carried out under the auspices of the health office it was found possible to maintain the blood parasite of the disease in serum containing hemoglobin. In some instances the blood parasite preserved in this manner remained virulent for a period of forty-two days. The parasite of the disease remained alive only for a short time in the muscles. As a result of the investigations by the imperial health office it is recommended that the material used in vaccination against Texas fever be obtained in a sterile condition, defibrinated, and preserved in an ice chest. It is further urged that it should be taken from animals only after fifty days following upon recovery from the disease. Attention is called to the desirability of making the preventive inoculation from four to six weeks before the animals are turned upon pasture and that it be given by means of the subcutaneous method in doses of 5 cubic centimeters.

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[a] Jour. Anat. et Physiol. [Paris], 40 (1904), No. 6, pp. 569–589.

[b] Compt. Rend. Soc. Biol. [Paris], 56 (1904), No. 13, pp. 606–608.

[c] Arb. K. Gesundheitsamte, 20 (1903), No. 1, pp. 1–77.

A new method of treating Texas fever has been suggested by Evers.[a] This author found, in making post-mortem examinations of cattle dead of Texas fever, that the observed alterations of various organs were to be ascribed to the destruction of hemoglobin, the coloring matter of the blood. The pathological symptoms were found to disappear as soon as the normal quantity of hemoglobin was restored. Evers therefore undertook experiments for the purpose of testing the effect of the artificial introduction of hemoglobin into cattle affected with Texas fever. For this purpose pure hemoglobin was produced and was prepared in tablets weighing 2 grams each. In all about forty-three cattle were treated in this manner, and of this number forty-one recovered completely. The hemoglobin was dissolved in physiological salt solution in the proportion of 1 to 50 during the first experiment, but later the percentage of hemoglobin was considerably increased. The hemoglobin was injected by the hypodermic method. Animals submitted to this treatment recovered rapidly, usually within from five to eight days.

Within recent years the existence of an extremely virulent form of hemoglobinuria has been recognized in South Africa. This disease has been extensively studied by Koch, Theiler, Stockman, Gray,[b] and others. At first the disease was believed to be identical with Texas fever, but merely of a more virulent form. Later, however, Koch called attention to certain striking differences between the African coast fever and true Texas fever. The disease is now recognized as distinct from Texas fever and is known by various names, such as African coast fever, Rhodesian redwater, East coast fever, tropical bovine pyroplasmosis, etc. It has been shown by extensive investigations in the English South African colonies that African coast fever is transmitted by two species of ticks, known as *Rhipice-*

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[a] Berlin. Tierärztl. Wchnschr., 1903, No. 52, pp. 793–797.

[b] Rhodesian Agr. Jour., 2 (1904), No. 1, pp. 8–18.

*phalus appendiculatus* and *R. simus*. Koch[a] carried on a long series of experiments in developing a method of vaccination against this disease and believed that he had perfected such a method. Recent experiments by Theiler,[b] Stockman, and others have thrown serious doubt upon the value of this method. Koch found that African coast fever could not be communicated in an acute form to susceptible animals by inoculation with blood drawn from either sick or recovered animals. In this respect the disease differs essentially from Texas fever. Repeated inoculations with blood taken from sick or recovered animals produced a slight effect, however, and ultimately specimens of the parasitic organism were found in the blood of animals thus treated. In his third report Koch recommended subcutaneous inoculation of susceptible animals with fresh defibrinated blood taken from recovered animals. This inoculation was to be repeated once a week for four weeks, then once every other week for two months, and afterwards once a month. Koch modified this line of treatment to the extent of recommending regular fortnightly inoculations in smaller doses for a period of four or five months. Doctor Koch believed that in a considerable percentage of cases immunity was thus produced. Gray, however, reports that this method was carried out strictly in accordance with recommendations on over 3,700 head of cattle, in which it was found that the percentage of mortality in treated animals was no less than in those which received no treatment. It is argued, therefore, that the failure of Koch's method leaves no means of combating the disease other than those which previous experience had suggested, viz, the suspension of transportation of cattle so far as possible, fencing, and systematic dipping for a period of at least two years, in addition to the complete exclusion of all cattle from infected areas for a period of at least fifteen months. In experiments reported by Theiler[c] unsatisfactory results were obtained from dipping and spraying experiments in which arsenical dips were used with or without the addition of izal and other substances. It appears that infection persists in a given locality for from fifteen to eighteen months. In Koch's study of the disease it was found that there are certain constant differences between it and Texas fever. In African coast fever the red blood corpuscles are more abundantly infected with the blood parasite, but the destruction of blood corpuscles is very slight as compared with that which takes place in cases of Texas fever. In African coast fever also there are observed prominent lesions in certain organs which indicate that the parasites accumulate in those parts in enormous numbers. In a small percentage of cases it was possible to determine that the animals were simultaneously affected with Texas fever and African coast fever. Stockman, however, as the result of his investigations believes that the more striking intestinal lesions observed in such cases are due to rinderpest. Stockman found that rinderpest and African coast fever frequently occur simultaneously in the same animal.

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[a] Agr. Jour. Cape Good Hope, 24 (1904), No. 5, pp. 549–560.

[b] Transvaal Agr. Jour., 3 (1904), No. 9, pp. 49–98.

Jour. Comp. Path. and Ther., 17 (1904), No. 3, pp. 193–203.

## RINDERPEST.

Rinderpest has been known so long and has been so thoroughly studied that naturally the more recent investigations have dealt chiefly with the means of combating it. The disease is known by a number of names in different countries, but rinderpest and cattle plague are the two most common terms. Nencki[a] in his studies of rinderpest found that the blood of animals which had recovered from the disease contains a substance which confers immunity on other animals. Considerable success was had in the preparation of an antitoxin for this purpose. After about two days, when it appears that infection has taken place, the animal receives a dose of therapeutic serum. Protective inoculation was brought about by this author by two methods, which differed chiefly in the length of time required for the operation. The injection of this immunizing serum appeared to have no influence upon the secretion of milk. Nencki found from his experiments that animals could be immunized against rinderpest by serum alone, by serum and virulent blood, and by inoculating the animal with virulent blood and then giving an injection of serum.

In a study of rinderpest carried out by Nicolle and Adil-Bey[b] it appeared that infection may pass from the mother to the young before birth. Inoculation with virus was uniformly fatal to highbred cattle, but was not fatal to native races. Considerable difference in the susceptibility to the disease, therefore, exists between different races of cattle. Some difference in the virulence of various fluids from infected animals was noted. The serum obtained from the brain and spinal cord was of about equal virulence. Serum from the body cavity produced fatal results when administered in doses of one-fourth cubic centimeter. Experiments with Asiatic races of sheep showed that ordinary inoculation of these animals produced only a slight fever reaction and no serious results. The use of bile gave variable results, but led to no definite conclusions, while the application of serum treatment for curative purposes was successful in about 50 per cent of the cases and produced almost complete immunity.

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[a] Arch. Sci. Biol. [St. Petersburg], 7 (1899), No. 4, pp. 303-336.

[b] Ann. Inst. Pasteur, 15 (1901), No. 9, pp. 715-733.

In Russia Dudukalov[a] found that after vaccination the animal at once acquired a great resisting power to rinderpest. From inoculated animals blood can be drawn in large quantities without greatly injuring the health of the animals and without weakening the protective power of the blood thus obtained. In South Africa rinderpest caused enormous losses during the years 1896 and 1898, and as a result of these outbreaks bile and serum inoculations were applied on a large scale. The preventive inoculations with bile proposed by Koch proved to be exceedingly effective, and the disease was apparently eradicated. Later, however, other outbreaks occurred on account of the fact that a few cattle in various parts of the country had not been inoculated. The study of these subsequent outbreaks of rinderpest showed quite conclusively that immunity had persisted for a period of four years. Theiler[b] therefore concludes that bile inoculation is to be recommended as a preventive measure in herds where no cases have occurred and also in infected herds. Many technical objections have been raised against the method of bile inoculation, but it has proved itself practical and efficient, as judged by the results.

In some experiments, however, as, for example, those of Tvaryanovich,[c] active immunity appeared to persist not longer than four to six months after vaccination. An outbreak of rinderpest in Shanghai was combated according to the method of bile inoculation. For this purpose gall bladders were removed from cattle just dead of the disease, and the bile thus obtained was inoculated into the dewlap of healthy cattle in doses of 20 cubic centimeters. The method was found to be exceedingly effective, inexpensive, and easy of application. According to the investigations of Lingard[d] in India active immunity to rinderpest begins to develop after the fifth day after injection of the bile; the passive immunity, however, is manifested immediately after inoculation. This author found that the breed is a very important factor in determining the dose of serum necessary for producing immunity. Half-bred hill and plains animals required from fifteen to eighteen times the quantity of serum which is necessary for producing immunity in plains animals. It was found that cattle and buffalo from the high region of the Himalayas are far more susceptible to rinderpest than any of the animals found in the lower plains regions. In a study of the methods of preparing antirinderpest serum, Dschunkowsky[a] found that it was possible to obtain a dry serum in a readily transportable form by desiccation of fluid serum in thin layers upon glass plates after the addition of one-fifth per cent of sodium hydrate. The dry serum was readily soluble in water, and appeared to be equally as effective as fluid serum.

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[a] Arch. Vet. Nauk, St. Petersburg, 31 (1901), No. 10, pp. 897–900.

[b] Monatsh. Prakt. Thierh., 13 (1901), No. 4, pp. 145–161.

[c] Arch. Vet. Nauk, St. Petersburg, 33 (1903), No. 1, pp. 25–27.

[d] Centbl. Bakt. u. Par., 1. Abt., Orig., 37 (1904), No. 2, pp. 246–248. Also notes on the different degrees of susceptibility to rinderpest exhibited by the various pure and mixed breeds of bovines and buffaloes submitted to serum test during the years 1899–1903. Muktesar, India, 1903, p. 12.

Motzarski[b] made a study of a serious outbreak of rinderpest in Samarkand. As a result of this investigation it was found that the development of the disease in isolated localities could be quickly and decisively checked by protective vaccination of all cattle. The effect of vaccination upon healthy animals was not serious.

Quite recently, Theiler[c] reports that the simultaneous inoculation of cattle with serum or immune blood and the virus of rinderpest has been extensively tried by veterinarians in South Africa. A study was made of the number of animals thus treated and the percentage of vaccinated animals which develop Texas fever as a result of vaccination. Theiler believes that simultaneous vaccination against rinderpest in a region in which Texas fever or other blood diseases prevail is exceedingly dangerous if blood is used as the material for inoculation. Lingard found that plains cattle could be perfectly protected against subcutaneous injections of virulent blood after receiving subcutaneous injections of normal bile at intervals of a few days or by receiving a soda solution of the precipitate obtained from the normal bile of cattle.

Many authors have conducted studies on the etiology of rinderpest. Thus far, however, the organism of the disease has not been isolated. Nicolle and Adil-Bey[d] have made experiments for the purpose of determining the size of the micro-organisms of rinderpest. It was found possible to select a Berkefeld filter of such a character that it would allow the organisms of rinderpest to pass through, but would not permit the passage of other micro-organisms. The same authors conducted experiments in the filtration of rinderpest virus under different conditions through different filters. The passage of virulent organisms through filters usually depends on the diameter of the pores of the filter, the thickness of the walls, and the surface of the filter in addition to such factors as the nutrient medium, temperature, and pressure. The filtrate obtained from the thin Berkefeld filter proved to be inactive, of vaccinating power, or virulent according to the conditions under which the filtration was done. From the experiments of Nicolle and Adil-Bey it is concluded definitely that the organism of rinderpest may pass through filters, but that the extent to which this occurs depends upon a number of conditions.

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[a] Centbl. Bakt. u. Par., 1. Abt., Orig., 36 (1904), No. 1, pp. 91–94.

[b] Arch. Vet. Nauk, St. Petersburg, 34 (1904), No. 2, pp. 144–173.

[c] Monatsh. Prakt. Thierh., 16 (1904), No. 4–5, pp. 195–204.

[d] Compt. Rend. Acad. Sci. [Paris], 134 (1902), No. 5, pp. 321–324.

### MILK FEVER.

The etiology and treatment of this disease has for many years received a great amount of attention from veterinarians, and since the development of Schmidt's[a] method of treatment with iodid of potash an unusually large number of experiments in the treatment of the disease have been reported. Notwithstanding the great amount of energy which has been devoted to the study of milk fever, there is no agreement as to the cause of the disease. Mutually contradictory theories have been proposed and the problem seems still to be far from solution. Some investigators believe that the disease is due to a bacterial organism. As a rule, however, digestive and circulatory disturbances in connection with the increased action of the udder at the time of calving are considered to be the immediate cause of milk fever. Within the past few years it has been found unnecessary to use iodid of potash infusions into the udder in treating the disease. Equally satisfactory results have been obtained from filling the udder with warm water or other inert fluids or with oxygen or atmospheric air. The results obtained from the use of the air treatment have been more satisfactory than those from any other line of treatment. It may be applied as the only remedy or in conjunction with Schmidt's treatment with iodid of potash or the use of other drugs. The striking results which have been obtained by investigators throughout Europe in the use of the air treatment have been, in general, interpreted as indicating that the beneficial results are due to relieving the blood pressure in the udder and thus restoring the normal blood pressure and preventing anemia of the brain. Knüsel[b] and Van Dulm[c] had excellent results from pumping air into the udder under considerable pressure. More than forty cases were treated by this method with complete success in every case. It is recommended that the air be filtered before being pumped into the udder. Egeberg[d] made use of this remedy in treating milk fever in sows and reported complete success. Wherever used, whether in Europe, America, or elsewhere, the results from the air treatment of milk fever have been eminently satisfactory. The majority of cases treated with this method show signs of relief within a few minutes and make a complete recovery within one or two hours, or at least much more rapidly than by Schmidt's method, or in other lines of treatment. Several investigators have reported cases of milk fever which were evidently not connected with calving. Thus, Meier [a] reported five cases in cows which had calved from four to eight months previously. In this author's opinion the chief cause of milk fever is excessive rations in concentrated feeding stuffs. In localities in which the disease has increased most rapidly, heavy feeding with grains (up to 18 pounds per day) has been indulged in for the purpose of increasing the milk flow. This excessive feeding may cause an unusual flow of blood to the udder. Meier therefore defines milk fever as a cerebral anemia caused by congestion of the udder and digestive apparatus. Results obtained by pumping air, water, or other fluids into the udder are explained as due to the fact that thereby the excess quantity of blood is forced out of the udder.

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[a] Rev. Vet. Toulouse, 28 (1903), No. 1, pp. 1–16.

[b] Schweiz. Arch. Tierh., 45 (1903), No. 1-2, pp. 56–59.

[c] Tijdschr. Veeartsenijk. Maandblad, 30 (1902), No. 3, pp. 111, 112.

[d] Norsk. Vet. Tidsskr., 15 (1903), No. 1, pp. 29, 30.

Höijer and Helander [b] had perfect success in treating cases of milk fever which occurred a few days before calving. Excellent results were obtained from the application of the air treatment. Normal parturition took place and the cows made complete recovery.

The Jersey Cattle Society of England have tried experiments in the treatment of cows before calving in order to prevent the development of milk fever. This treatment, which has proved to be quite satisfactory, consists in giving especial attention to the comfort, temperature, conditions, etc., of cows for a period of four to six weeks before calving. In combination with this treatment it is usually recommended that only a portion of the milk be drawn from the udder at each milking for a few days after calving.

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[a] Berlin. Tierärztl. Wchnschr., 1904, No. 6, pp. 89–92.

[b] Finsk Veterinärtidskr., 10 (1904), No. 2, pp. 46–49.

# PROGRESS IN AGRICULTURAL EDUCATION, 1904.

By A. C. True,
*Director of the Office of Experiment Stations.*

## EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

The United States Department of Agriculture has continued its work of training agricultural experts, especially through a corps of scientific aids and student assistants, brought together from the agricultural and other colleges, and given special instruction in connection with the work of the different bureaus of the Department. In his annual report for 1904, the Secretary of Agriculture mentions some other ways in which the influence of the Department is being directly exerted in the field of education.

> The Department is interested in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. The mode of teaching and the results obtained were made an important part of the work of the convention of Weather Bureau officials which was held at Peoria, Ill., in September, 1904. At an increasing number of educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology. * * *
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> Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more intimate and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations. * * *
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> The Department is not an educational institution in the strict sense of the word, but it can do and is doing much to bring home to the people in all walks of life the importance and value of the farm and its productions. The Bureau of Plant Industry is making a special effort to encourage the study of plants in the public schools. The future welfare of this country depends upon its agricultural development, and it is important and vital that a knowledge of the opportunities in this field should early be brought to the attention of the child. Unfortunately, our system of elementary education is such as to leave no impression on the child's mind of the importance, value, and usefulness of farm life. The child is, in many ways, brought early into contact with facts which point to him the value of commercial life. He is, therefore, early inoculated with the belief that to reach the highest possibilities he must, if he is

on the farm, migrate to the city. It is to be regretted that farm life in the past has not always been conducive to the encouragement of young men to remain on the farm.

Very little effort has been made to overcome the general belief that there is always a great amount of drudgery connected with the farm and that the opportunities in this sort of occupation are narrow and limited. When we see the rapid advances that are being made in agriculture along all lines and note the need for bright young men in this field, the opportunities offered by the cultivation of the soil seem as great as in any other field. In order to bring these matters clearly home to the children, efforts are being made by the Department to encourage the growing of plants in connection with the public school work. The general distribution of seed is being handled in such a way that the encouragement of plant growing will be a feature of it. Wherever it has been practicable to influence school authorities, this has been done. Various members of the staff of the Bureau are constantly endeavoring, by publication of papers, lecturing, etc., to point out the advantages of rural life.

The total number of publications issued by the Department in 1904 was 972. Of these 379 were new, comprising about 23,000 pages of matter. The number of copies of publications issued during the year aggregated 12,421,386. The Department Editor reports a constantly increasing demand for these publications by educational institutions, mainly for class work.

In order to make the Department publications more thoroughly available to persons using them, printed index cards for these publications are sent to a large number of libraries. During the past year a beginning has been made of preparing index cards for three important agricultural periodicals. The printing, distribution, and sale of these cards is carried on in cooperation with the Library of Congress.

## EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

### RELATION TO AMERICAN INSTITUTIONS.

As a branch of the Department of Agriculture this Office continues to lend its aid to the forward movement in agricultural education, partly through cooperation with the Association of American Agricultural Colleges and Experiment Stations, in connection with which the Director of this Office is chairman of the standing committee on methods of teaching agriculture.

The educational publications of this Office for 1904 included a number of bulletins, circulars, and other documents, as follows: Bulletin 127, Instruction in Agronomy at Some Agricultural Colleges, by A. C. True and Dick J. Crosby; Bulletin 139, Special and Short Courses in Agricultural Colleges, by Dick J. Crosby; Circular 52, A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools, by Dick J. Crosby; Circular 53, Report of the Committee on Rural Engineering of the Association of American Agricultural Colleges, by W. E.

Stone and others; Circular 55, Relation of the Natural Sciences to Agriculture in Four-year College Courses (this being a report of the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations); Document 706, The American System of Agricultural Education, by A. C. True and Dick J. Crosby, and Document 708, Organization and Work of Agricultural Experiment Stations in the United States, by Dick J. Crosby. As far as his other duties will permit, Mr. Crosby is especially engaged in the educational work of the Office, and is also giving particular attention to the extension work of the colleges in nature study, school gardening, and elementary agriculture. The calls for lectures on the various phases of the extension work before teachers and others interested in this work have been more numerous than ever, and while it has been possible for the Office to be represented at a number of State institutes and other meetings attended by a total of about 4,000 teachers, many invitations to appear before such public gatherings have of necessity been declined.

The Office is in correspondence with a large number of college and school officers and teachers in this country and abroad, and aids them in securing the publications of the Department for use in educational work.

### RELATION TO FOREIGN INSTITUTIONS.

The Office is also following up the progress of agricultural education in foreign countries. Among the new agricultural institutions recently established abroad the following are especially worthy of mention:

The Imperial Agricultural College of India, endowed with $150,000 by Mr. Henry Phipps, of Pittsburg, Pa., will be located at Pusa, and will include a high-grade agricultural college and central research station, an experimental farm, and a cattle-breeding farm. The funds yielded by the endowment will be supplemented with appropriations from the imperial treasury.

Japan also has a new agricultural college, the third to be established in that country, which has been located at Morioka, under the directorship of a graduate of the Michigan Agricultural College. In France a colonial school has been established in connection with the university at Nancy for the purpose of giving instruction in forestry, agricultural economics, etc., to prepare students for positions in the French colonies.

The Province of Nova Scotia has established an agricultural college on its farm at Truro, where a $30,000 agricultural building has been erected. Courses of instruction at this college will be suited especially to the needs of farmers and farmers' sons. The institution will include departments of agriculture, horticulture, agricultural chemistry and physics, nature study, English, mathematics, farmers' institutes, and demonstration and research work. Short courses of about two weeks each will be held during the winter. In addition to the regular staff of instructors for the longer courses specialists will be engaged to assist in instruction, especially in short courses.

A royal school has been incorporated under the laws of the Province of Quebec for the purpose of establishing and carrying on agricultural schools and experimental farms. The school is to maintain two or more schools and experimental farms in the province, one to be located in the district of Montreal and one in the district of Quebec. Each school will contain accommodations for at least 50 pupils, and will give a three-year course, tuition and board being free of charge. The course will include all branches of agriculture, horticulture, arboriculture, dairying, slaughtering and curing of meats, carpentry, blacksmithing, and such other trades as may be useful to farmers. The school will establish experimental farms and "farms for tuition purposes," will clear and improve land and dispose of the same to its graduates and others, and will make advances to settlers to enable them to take up lands.

Sir William C. Macdonald, of Montreal, who has taken a deep interest in rural education and recently contributed funds for the establishment of concentration schools as an experiment, has decided to establish the Macdonald Foundation for Rural Education in Ste. Anne de Bellevue, 20 miles west of Montreal. A site of about 700 acres of first-class land, with fine exposure overlooking the Ottawa River, has been purchased. Prof. James W. Robertson, commissioner of agriculture and dairying of the Dominion government, will be at the head of the new institution.

It is proposed to have three departments, i. e., of research, of instruction, and of farms. The department of research will comprise research work in the sciences as related to agricultural and horticultural operations and to rural life generally. The department of instruction will provide long and short courses, and will furnish a headquarters for advanced education bearing upon rural life in Canada. In addition to carrying on work along lines somewhat similar to those followed at the best colleges of agriculture, there will be a division of household science, provision for special courses in nature study for teachers of rural schools, and a division of manual training.

The department of farms will provide for (1) a dairy farm, (2) a meat-producing farm, and (3) a "small cultures" farm. Each of these will be arranged, equipped, stocked, manned, and managed so as to illustrate the best known systems and methods of profitable agriculture. Within each farm there will be a series of small farms of from 1 to 5 acres. Apprentices will be received and, in addition to the general work of the larger farms, will be given charge of these small farms for actual practice work. These small practice farms are an outgrowth of experience with school gardens at rural schools, where a plat is assigned to each child.

The main buildings will be constructed in a fireproof manner, and will include residences for men and women students. The whole expense of establishing this institution will be borne by Sir William Macdonald, who will also endow it.

The Aberdeen and North of Scotland College of Agriculture was opened to students October 11, 1904. The college is connected with the University of Aberdeen and Gordons College, Aberdeen. Both of these institutions are represented on the board of governors of the college, and supply lecture rooms for the use of students in the college of agriculture. Three courses of study are offered—one leading to the degree of bachelor of science in agriculture, another to the university diploma in agriculture, and a third to the national diploma in agriculture. The course leading to the university diploma in agriculture extends over two winter sessions and corresponds closely to the agricultural high school courses in some of the agricultural colleges in this country. The board of governors of the college is composed of members appointed by the county and city of Aberdeen, the counties of Banff, Ross, Cromarty, Kincardine, and Elgin, the Aberdeen County Committee on Secondary Education and County Council, the University of Aberdeen, the Highland and Agricultural Society, and Gordons College. The staff of the institution consists of five professors and lecturers, six assistants, and four demonstrators. At the head of the staff is R. B. Greig, professor of agriculture, economic science, and engineering field work. In addition to the instruction given in the college it is planned to establish, "if possible, research stations or experimental farms."

The practical Gardening School of the Royal Botanic Society of England has a women's branch in which are trained young women who have obtained scholarships from the London school board, and who intend to adopt gardening as a profession. It is reported that women students from this school readily find situations and that many people are now employing women as gardeners in preference to men. The students who wish to learn gardening as a pastime are allowed to attend this school on special days.

Much attention is being given in a number of foreign countries to the preparation of teachers for giving instruction in elementary agriculture, nature study, and school gardening, and also to the giving of practical instruction to women in agriculture and horticulture. Last year eleven teachers were sent from Canada to agricultural institutions in this country to prepare for nature-study work in the rural schools of the Dominion. In the British West Indies the imperial department of agriculture is devoting much attention to the preparation of teachers in agriculture, and in the British islands and Germany schools for the training of women in horticulture and floriculture are being developed. In the latter country a school of this nature has recently been established at Godesberg on the Rhine.

In all the foreign countries giving attention to instruction in agriculture of secondary or elementary grades various forms of itinerant instruction—traveling teachers, traveling dairy schools, farmers' institutes, winter schools, and other forms of university extension—are the subject of careful consideration and experiment. The trend of this instruction and the increasing attention devoted to it are indications that it is considered an essential feature in the systems of education in these countries.

## EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

At the eighteenth annual convention of this association, held at Des Moines, Iowa, November 1 to 3, 1904, educational problems were largely discussed. The address of the president, Dr. W. O. Thompson, of the University of Ohio, dwelt on the importance of the broad organization of the agricultural colleges to meet the needs of modern agriculture and advocated the formation of extension departments in these colleges to stimulate agricultural education in the rural communities. President K. L. Butterfield, of the Rhode Island Agricultural College, in a paper on the Social Phase of Agricultural Education, laid down the broad proposition that "the permanent function of the agricultural college is to serve as a social organ or agency of first importance in helping to solve all phases of the rural problem." To carry this out the college must not only provide adequate technical courses in agriculture, but also train men and women for social leadership among farmers and create comprehensive extension departments for work among the rural people. In a discussion on the advisability of providing secondary and short courses in agriculture in the land-grant colleges much variety of opinion was developed, though most of the speakers urged the present necessity of maintaining such courses at these institutions. The question of "what can and should be done to increase the interest in and appreciation for the agricultural side of technical training" was earnestly debated, and in this connection the importance of the broad development of the agricultural courses and the desirability of dividing the instruction in different branches of agriculture among a number of instructors were emphasized.

The reports of the standing committees on rural engineering and on the methods of teaching agriculture are given elsewhere in this report.

## THE AGRICULTURAL COLLEGES.

The agricultural colleges have displayed great activity in providing special buildings and laboratories for instruction in the different divisions of the science of agriculture.

### APPROPRIATIONS.

The appropriations of the year for new buildings at the colleges and for maintenance of these institutions have been very large. The State legislature of Virginia appropriated $165,000 for buildings, equipment, and improvements at the agricultural college. Iowa college has an addition of $50,000 to its maintenance fund, an appropriation of $95,000 to complete the central building, $45,000 for a dairy building and $10,000 for equipping it, $22,000 for a new dairy farm and $7,000 for equipment, and $54,500 to begin the construction of a heating plant, with several minor items, including $15,000 annually for the experiment station. The College of Agriculture of Cornell University is now definitely organized under State support with an appropriation of $250,000 for buildings and equipment. The last legislature of Florida gave the university about $60,000 for maintenance during the next two years. The Illinois college of Agriculture has appropriations for a building for beef cattle, $25,000; another for horticulture, $12,500, and for a storage building for agronomy, $21,500. Minnesota has appropriations aggregating $300,000 for building purposes, including, among other items, $218,000 for a main agricultural building. Pennsylvania State College has completed during the past year a $140,000 assembly building, donated by Mr. and Mrs. Charles M. Schwab; a $150,000 library building, donated by Andrew Carnegie, and the $100,000 dairy wing of the new agricultural building, for which the legislature has virtually pledged itself to appropriate an additional $150,000. The University of Vermont has recently received an appropriation of $60,000 for an agricultural building, to be known as Morrill Hall. There are also many smaller appropriations for barns and other less expensive buildings, for maintenance, and for special lines of instruction.

### NEW BUILDINGS.

A building to be used in connection with the instruction in live stock at the Minnesota School and College of Agriculture has recently been erected. The building will serve as headquarters for the live-stock department of the station as well as the college, but is designed principally for the instruction in live-stock judging and other branches of animal husbandry.

It is quite unique for a building of this sort, and includes a number of features not usually found in the live-stock pavilion or the barn. It is, in fact, a combination of the live-stock pavilion with recitation rooms and offices and the stable. The stables accommodate only a limited number of animals and are intended for temporary use—to house the animals while they are being used for instruction purposes. Stock for this purpose is frequently borrowed in order to obtain suitable specimens for illustration, and such animals will be stabled in the barn forming a part of this building while they are at the college grounds. Stock belonging to the college will also be more conveniently housed in this building during the period when it is being used.

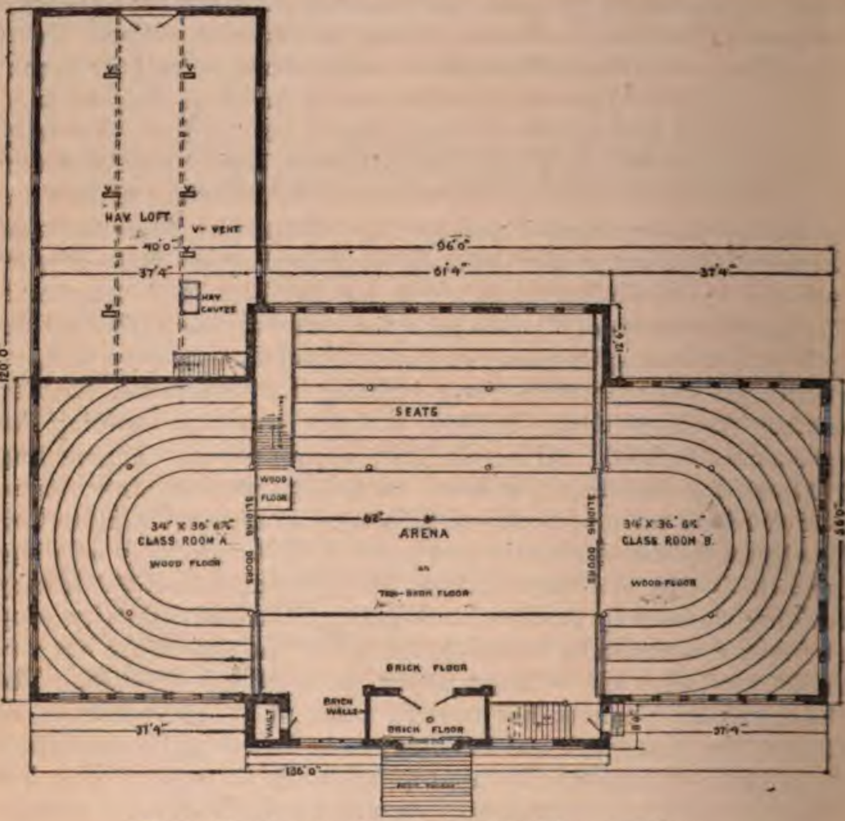
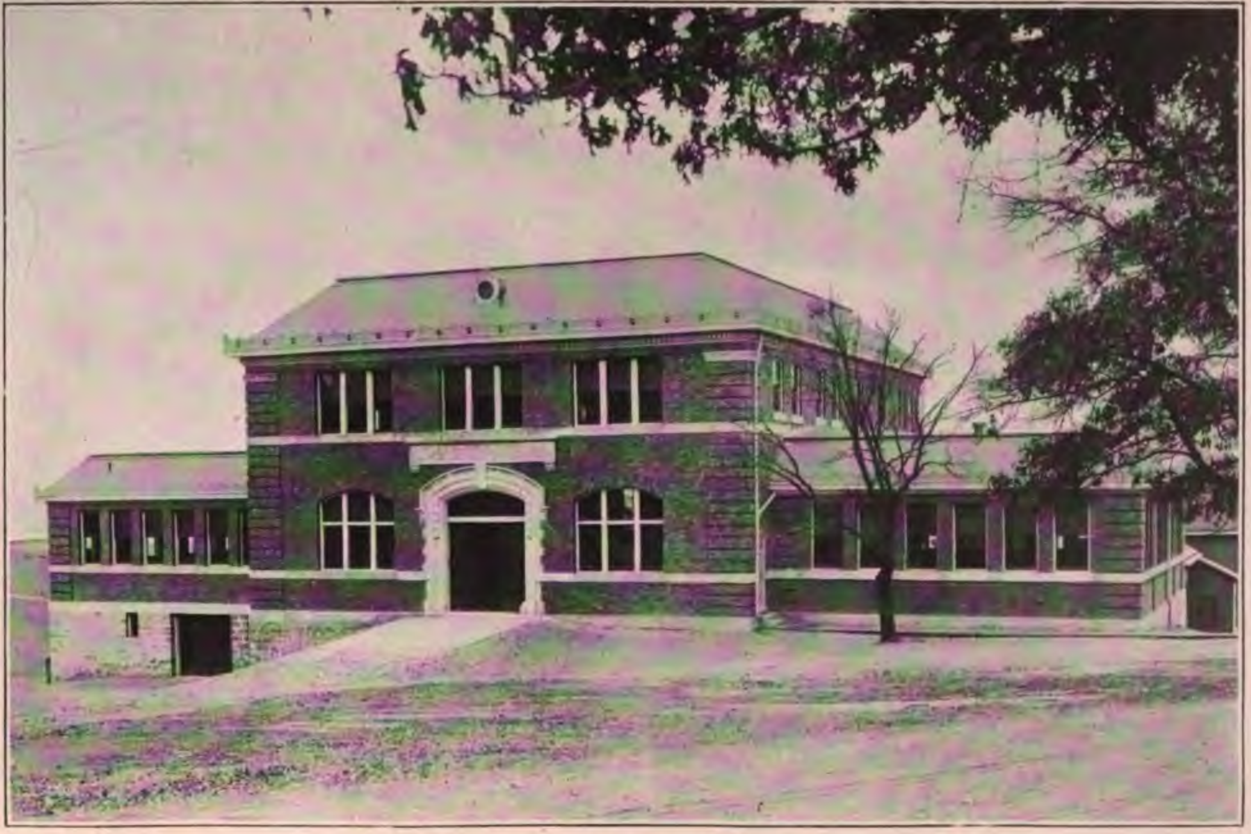


FIG. 6.—First-floor plan of live-stock pavilion, Minnesota College.

The new building is of brick, with blue limestone foundation, Indiana buff Bedford stone trimmings, and slate roof. It has a frontage of 136 feet, with a depth of 76 feet in the main part. As seen in front (Pl. XXVI), it presents the appearance of a central part with wings on either side.

The central portion of the building is two stories high. The first floor (fig. 6) is occupied by an arena extending across the entire front,



MINNESOTA COLLEGE LIVE-STOCK PAVILION.

with class rooms at either end, which can be cut off by sliding doors. The arena proper is provided with a tan-bark floor 25 by 104 feet in extent, making it possible to study the gait of a horse without going out of the building. The central part has seats at the back for 225 persons. The two class rooms in the wings will accommodate about 200 students each, the seats being arranged in semicircular form. All can be thrown together into one large audience room for demonstrations or meetings.

The animals will be brought up to the arena from the stables below over inclines built at an easy grade. Between the tan-bark floor and the front of the building will be an area covered with a brick floor, which can be used for instruction in harnessing and hitching up teams, grooming horses, etc.

The second floor of the building contains two offices for the department of animal husbandry, a workroom, a museum, and a class room for animal feeding. The workroom will be used for the study of pedigrees, the keeping of feeding records, and for microscopic work. It is 22 by 28 feet, while the museum and class room are each 30 by 39 feet in size. On this floor will also be located a dark room, toilet, and a vault for the storage of records and other valuable books.

In the left or east wing are located the stables for the live stock, in a basement and subbasement. The land slopes away from the front in such a way as to make both the basement and the subbasement almost entirely above ground. The subbasement will be used for cattle and the floor above for horses. This wing runs back something over 50 feet beyond the main part, so that on the basement floor (horse barn) it has a depth of 120 feet from front to back and a width of 40 feet.

The subbasement or cattle barn (fig. 7) has a cement floor and is provided with iron stable fittings. It contains a number of box stalls and a root cellar, which extend into the side hill, and is provided with hay chutes, a manure chute, and a ventilation system. The tunnel furnishing the building with heat from the central heating plant enters the building through the subbasement.

The horse barn (fig. 8), located on the floor above, is provided with box stalls, and in the front part contains a large wagon room. On this floor also is located the bins for grain, two rooms for attendants, and a toilet. The hay loft is in the attic above the portion of the wing used for stables. The finish in the stables is in the rough brick; the bed rooms are plastered and finished in pine, as are also the offices.

The building was erected out of a State appropriation and cost with equipment about $35,000. It is heated from the central heating plant of the college and lighted throughout by electricity. It is

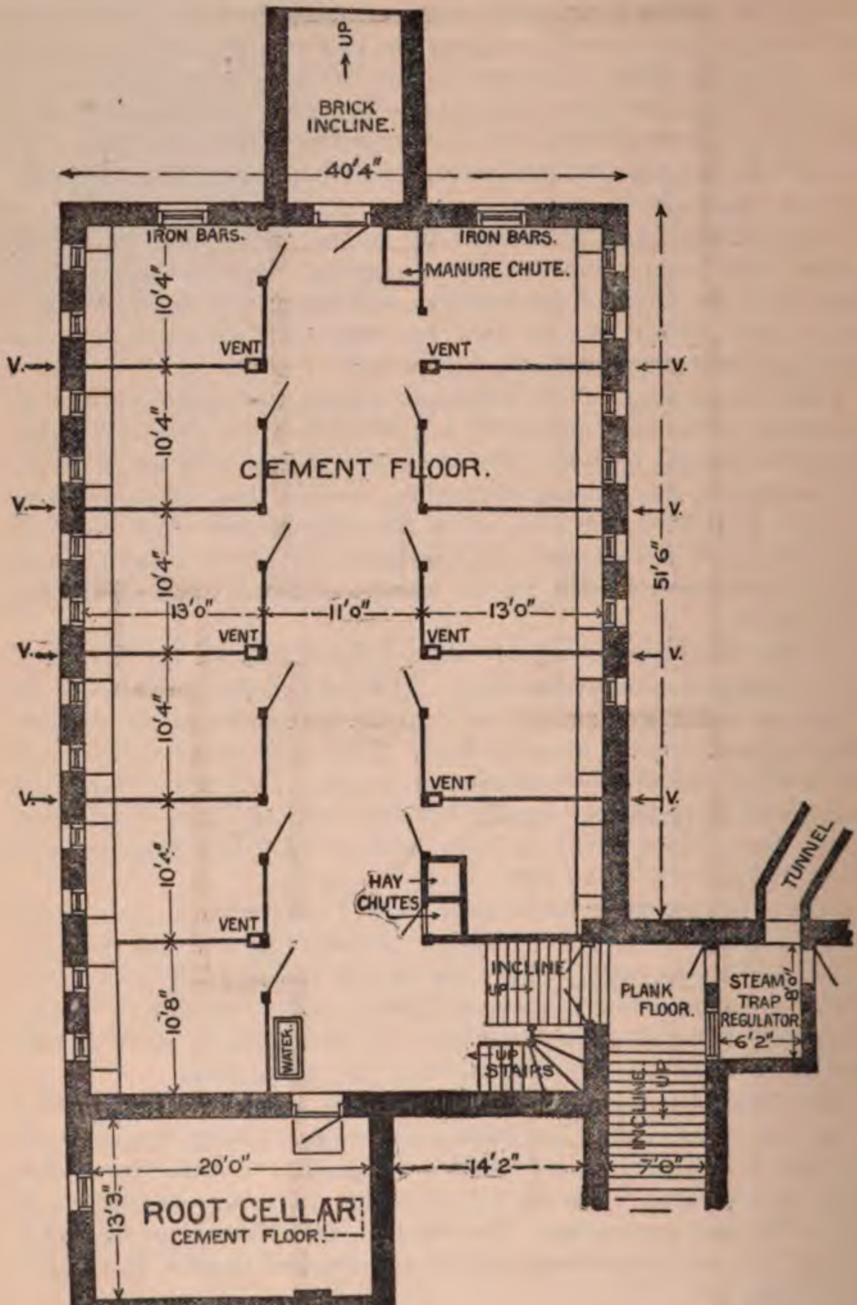


FIG. 7.—Subbasement (cattle barn) of live-stock pavilion, Minnesota College.

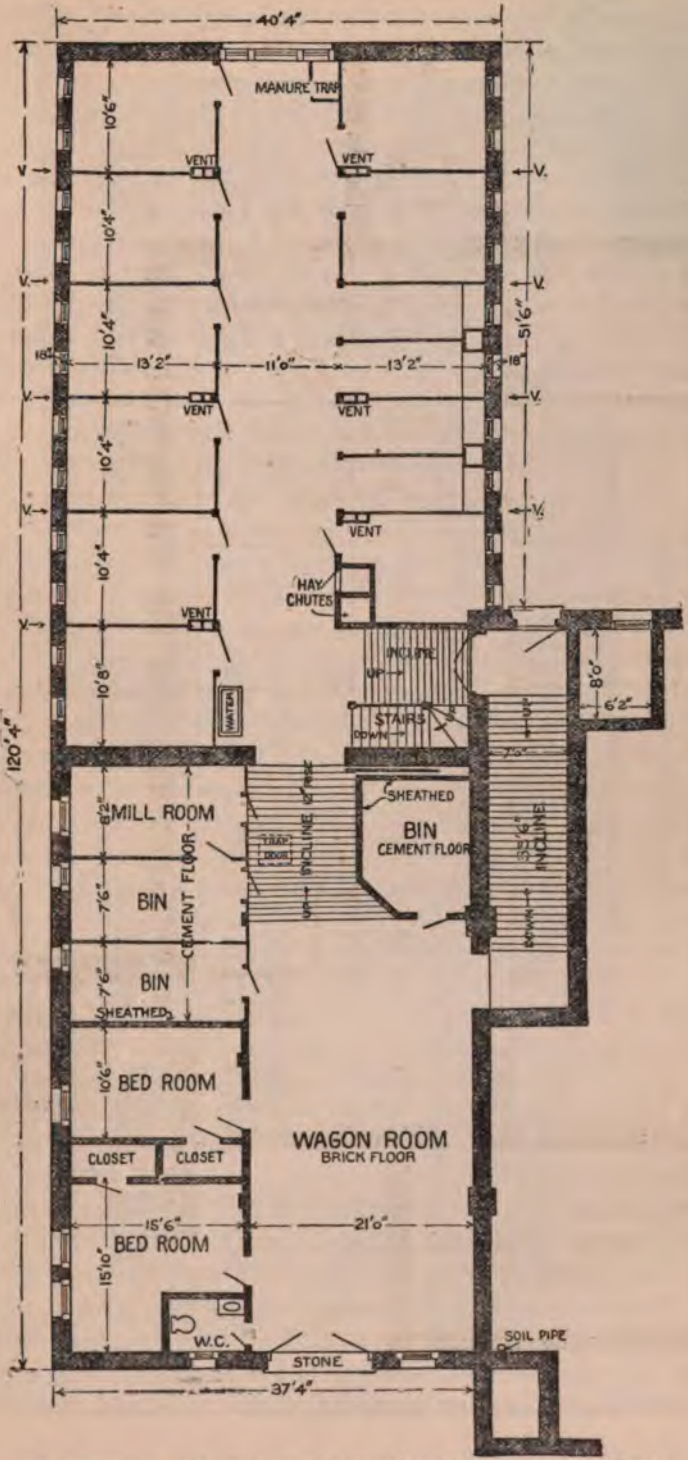


FIG. 8.—Basement (horse barn) of live-stock pavilion, Minnesota College.

centrally located, convenient to the cattle stables and the hog and sheep barns and adjacent to the building erected a few years ago for slaughtering, cutting up, and curing meats.

At the Iowa Agricultural College a new dairy building, to cost about $60,000, is in process of erection. (Pl. XXVII.) The building is 110 by 60 feet, with three stories, an attic, and a basement under the east half. It is built of buff pressed brick, trimmed with buff Bedford limestone, and covered with red tile. The construction is fireproof, the floor and roof being of reenforced concrete. The dairy room and laboratories are finished with buff, trimmed with light red pressed brick, and wainscoted with brown, green, and white enameled brick. In the offices, the class rooms, and the library the walls are plastered. The ground floor and the halls are covered with tile. The other floors are of light-colored cement and the ceilings are plastered. Heat will be supplied eventually from a central system. Electric lights, gas, and distilled water are provided where needed.

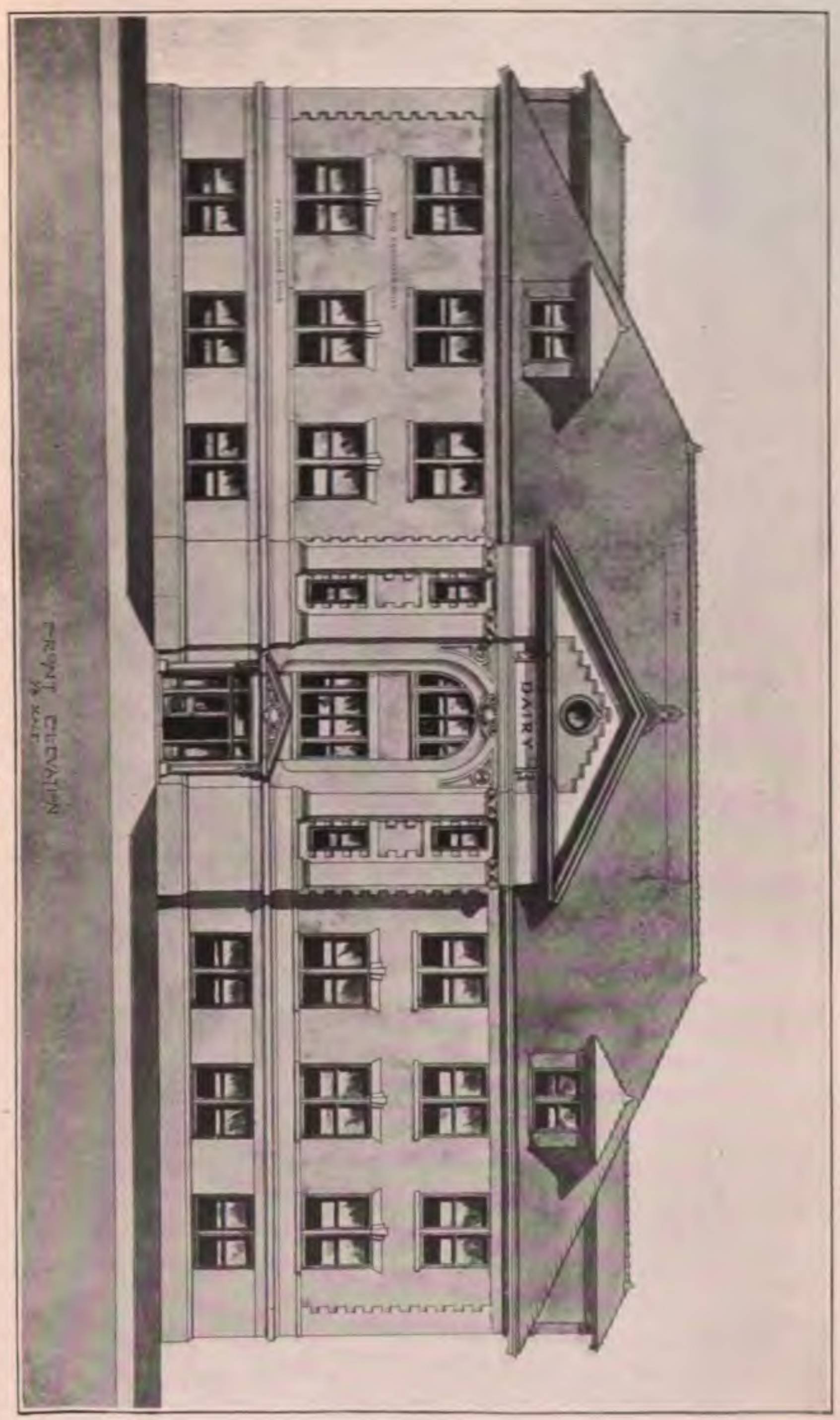
Power will be transmitted from the central power station by means of electricity, each machine being run by a separate motor. A freight elevator reaches all the floors. Close-grained wood, finished with analine black, will be used for the tops of laboratory tables. Lead sinks will be put in the testing room and enameled sinks elsewhere.

The attic and a part of the second floor are left unfinished, but will be completed when the necessary funds are available.

The basement contains a small boiler for supplying steam in the summer for heating water and running turbines; a mechanical refrigerating plant, consisting of two compressors—one for cooling and one for making ice—with a combined capacity of 20 tons; a room for students' lockers; a large room for a museum, and a room for cold storage of fruits to be used by the horticultural department.

On the ground floor is the creamery for making butter on a large scale. (Fig. 9.) The milk will be received on a covered platform, from which it can be pumped to the separators, carted to the cheese room, or lifted on the elevator to the farm dairy. The separators will be in the middle of the large room, the ripeners in a cream room of glass and enameled brick, and the churns in the adjoining room. Between the churn room and the cheese room are eight small, well insulated rooms fitted with refrigerating coils and ventilating devices. They are adapted for refrigerator, storage, and curing rooms, and some of them are to maintain temperatures as low as —5° F. Above these will be placed the skim milk and buttermilk tanks. The cheese room is fitted for making both domestic and foreign varieties of cheese.

Opening into the creamery are a small testing laboratory for creamery work, an office for the instructor in butter making, and a bottling and pasteurizing room for handling market milk and starters. On



IOWA COLLEGE DAIRY BUILDING.

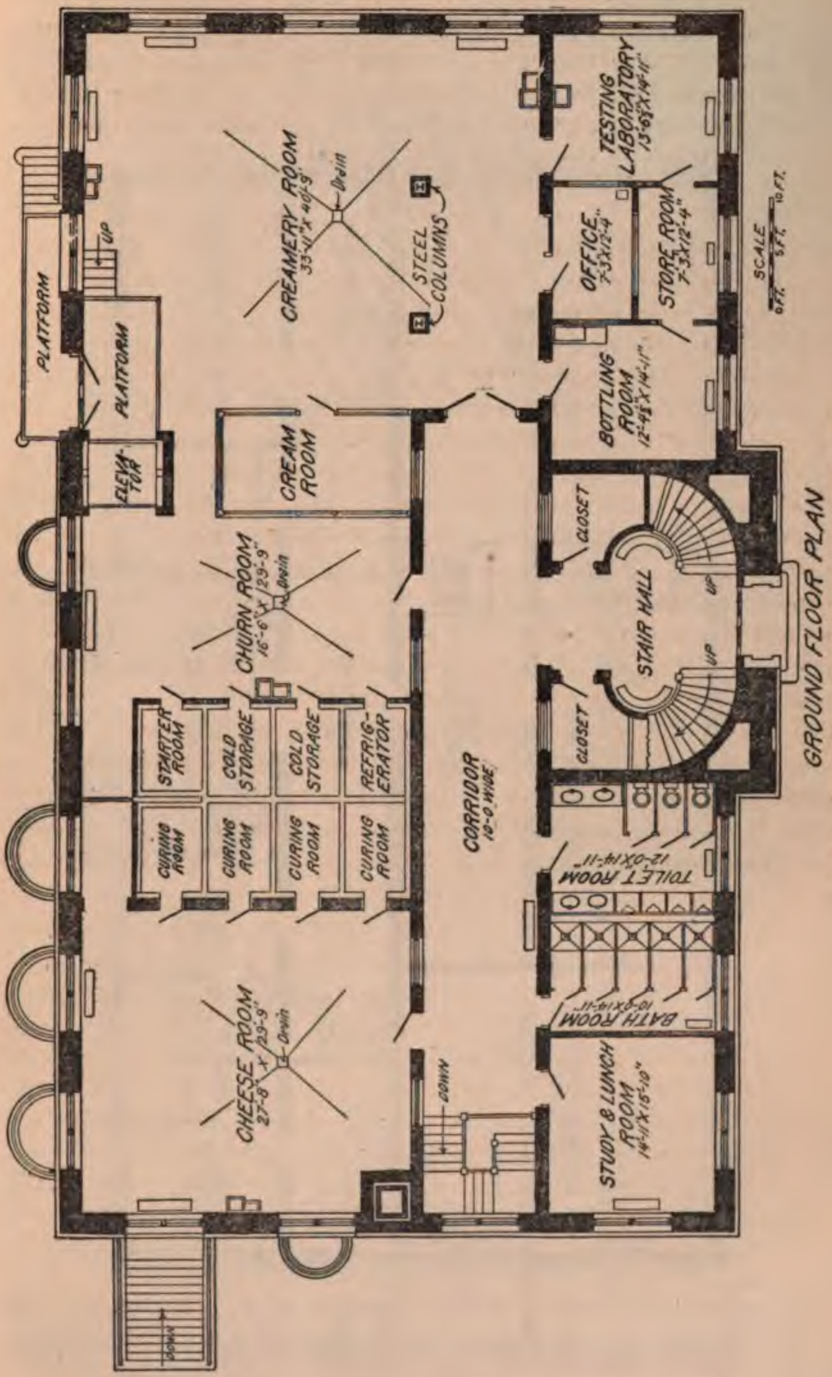
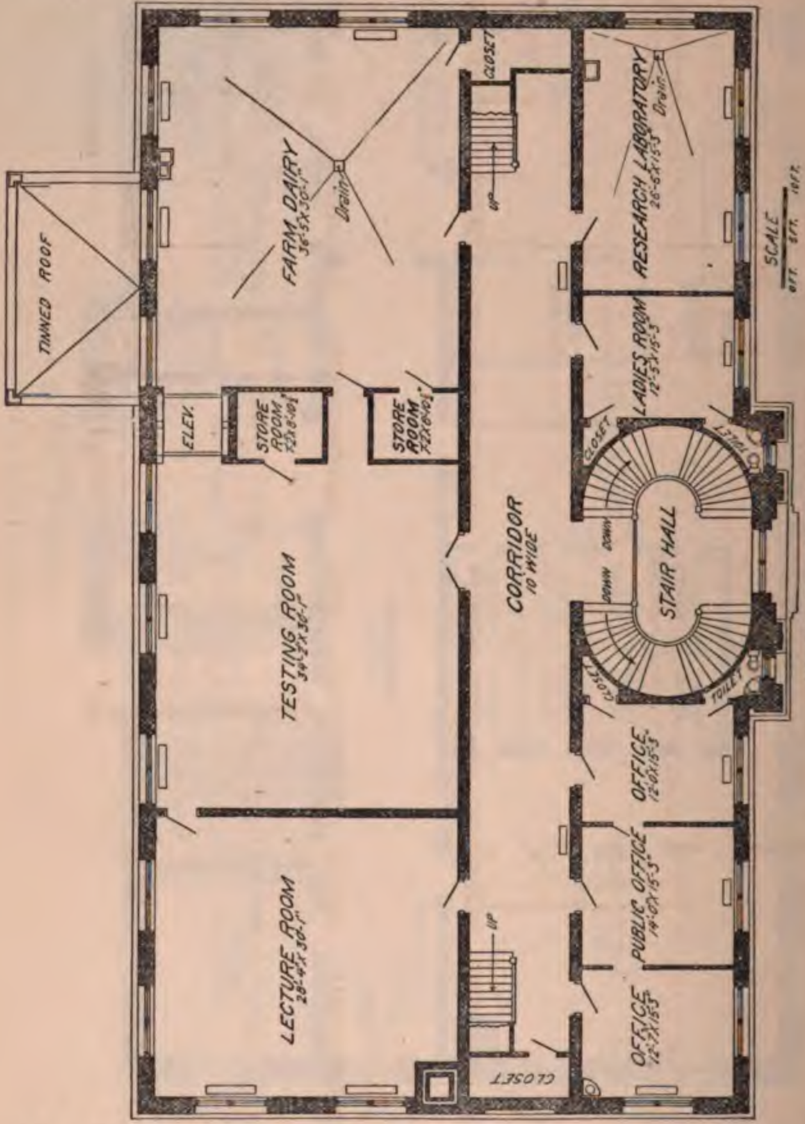


FIG. 9.—Ground-floor plan of dairy building, Iowa College.

the other side of the stairway are a toilet room, shower baths, and a study and lunch room for students.

On the first floor (fig. 10) are three large rooms—a farm dairy equipped for making butter on the same scale as on the farm, a milk-testing laboratory capable of accommodating 24 students at one time, and a lecture room with a seating capacity of 75. Across the hall are the private offices of the professor of dairying and his assistant, a public office, a ladies' room, and a laboratory for research work in dairying.



FIRST FLOOR PLAN

FIG. 10.—First-floor plan of dairy building, Iowa College.

The south end of the second floor (fig. 11) is occupied by the

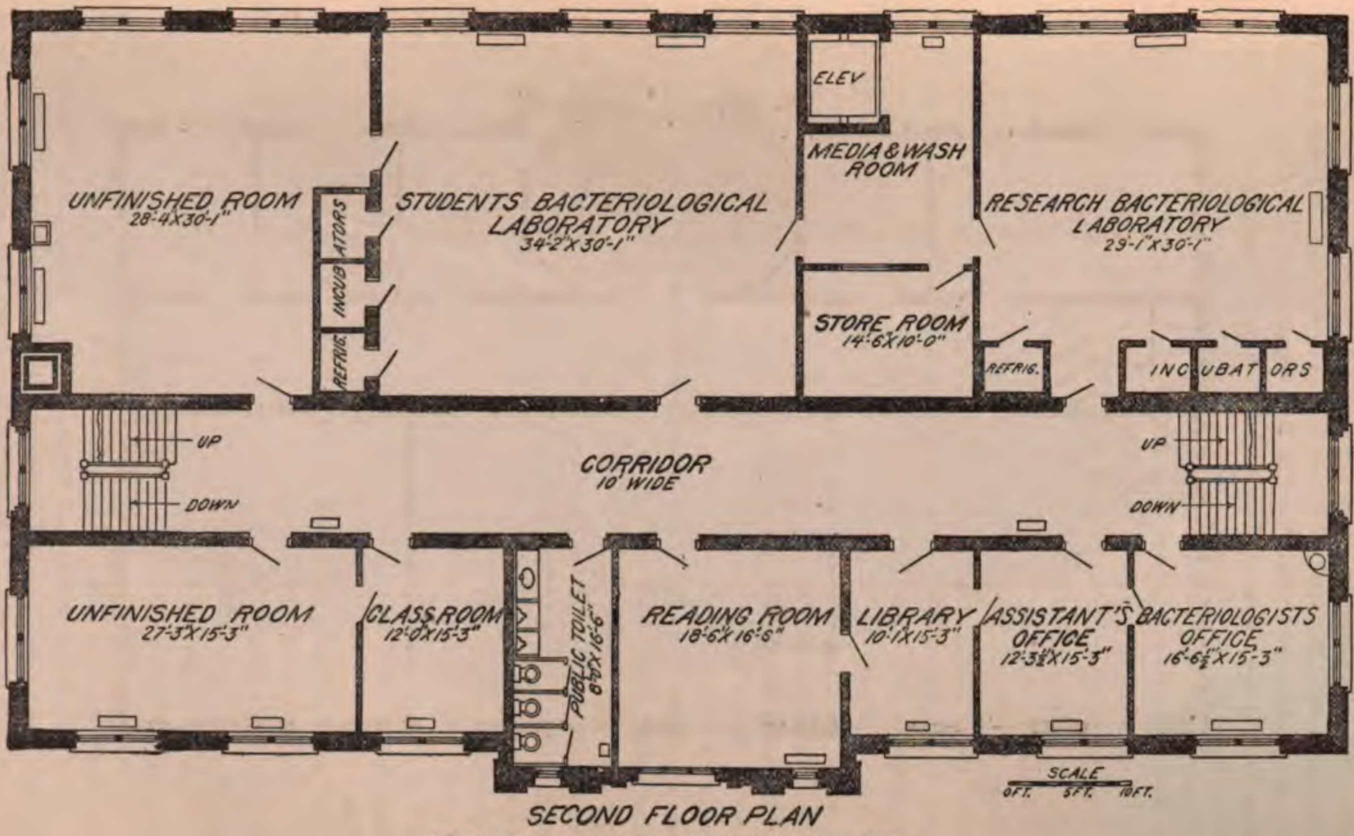


FIG. 11.—Second floor plan of dairy building, Iowa College.

research dairy bacteriological laboratory, with adjoining storeroom and a room for washing dishes and preparing media. Next to these is the students' laboratory for dairy bacteriology, with a capacity of 24 students. Both laboratories are connected with small insulated rooms to be used as incubator, refrigerator, and pure-culture rooms. Across the hall are offices for the dairy bacteriologist and assistant, a library, a reading room, and a small class room for 12 students.

A few rods from the dairy building will be erected a small house for the skim-milk weigher and buttermilk spigot. This scheme has been adopted in order to remove the slops and flies as far as possible from the dairy building.

The dairy building recently completed at the Pennsylvania State College (Pl. XXVIII) is built in the Italian style and contains two stories above a high basement. The base is of Hummelstown brownstone, the superstructure of a rich Roman brick with terra-cotta trimmings. The building is constructed in the most substantial manner and is fireproof throughout. The corridors and workrooms in the dairy building have tiled floors and a tiled wainscot 6 feet high, the remainder of the interior finish being of red oak. A tunnel connecting with the college heating plant serves to bring high and low pressure steam and electricity to the building, which is heated and ventilated by the Sturtevant system. The machinery will be operated by electric power, but high-pressure steam for operating steam turbine separators is also provided, while the laboratory will be supplied with gas from a gasoline plant.

The basement of the dairy building contains a room 22 by 44 feet for instruction in private dairying, a workshop 21 by 35 feet, two cheese-curing rooms—one with refrigeration, a fan room, and an ice-machine room.

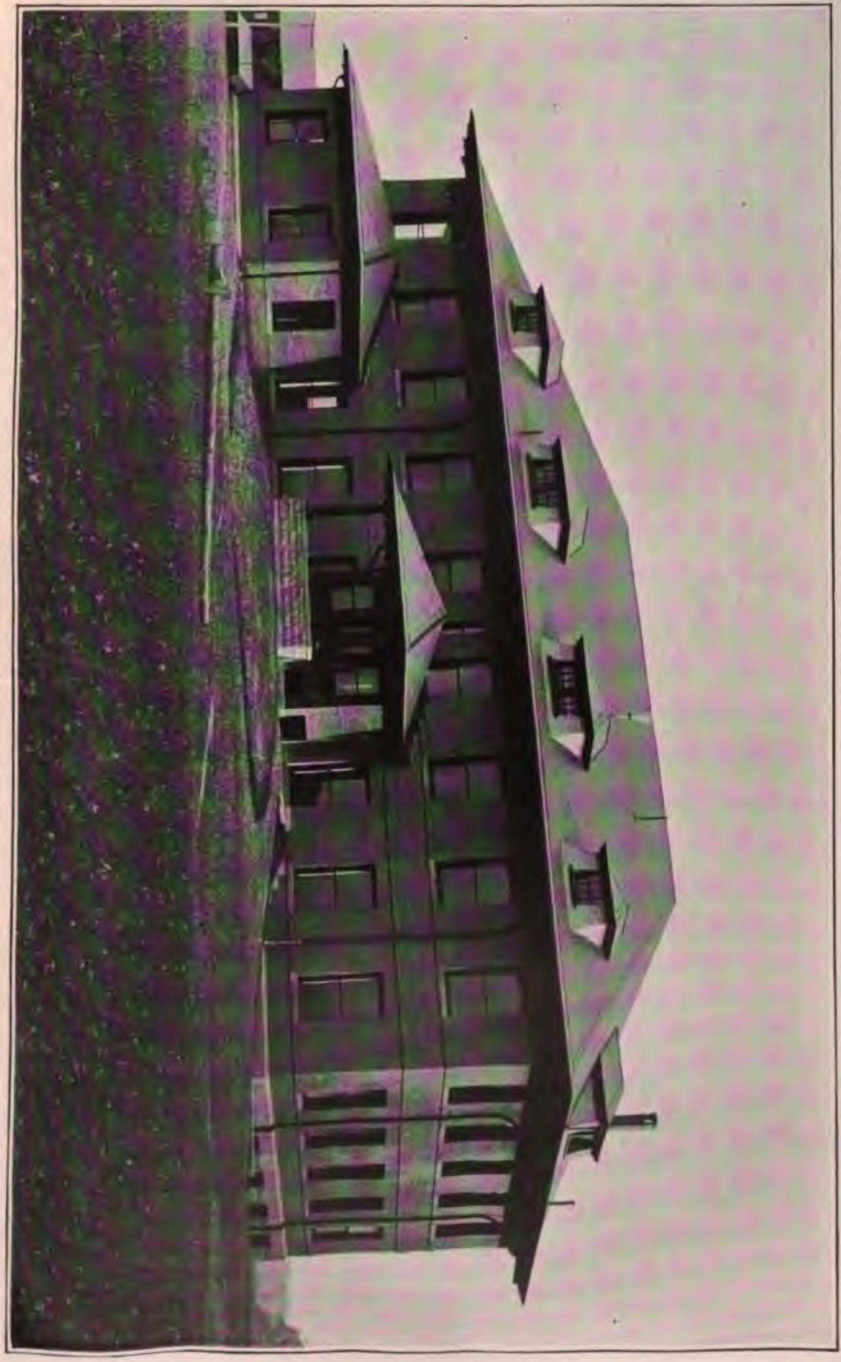
On the main floor is the butter room, 45 by 57 feet, an intake and wash room, a cheese room 34 by 35 feet, a large refrigerator, a commodious toilet and locker room, a milk-bottling room, and an office.

The second floor contains a large lecture room 34 by 44 feet, a small lecture room 22 by 35 feet, a milk-testing laboratory 34 by 35 feet, and offices for the professors of dairy husbandry and of agricultural bacteriology.

Ample storage room is provided in the attic, and a large lift connects all the stories.

The Kansas State Agricultural College has recently completed a dairy building at a cost of $15,000. (Pl. XXIX, fig. 1.) The building is of stone, one story and basement, and will be used exclusively for class room and practical work in dairying.

The New Hampshire Agricultural College has completed during the year a new range of seven greenhouses, at a cost of $7,000. One



PENNSYLVANIA COLLEGE DAIRY BUILDING, REAR VIEW.

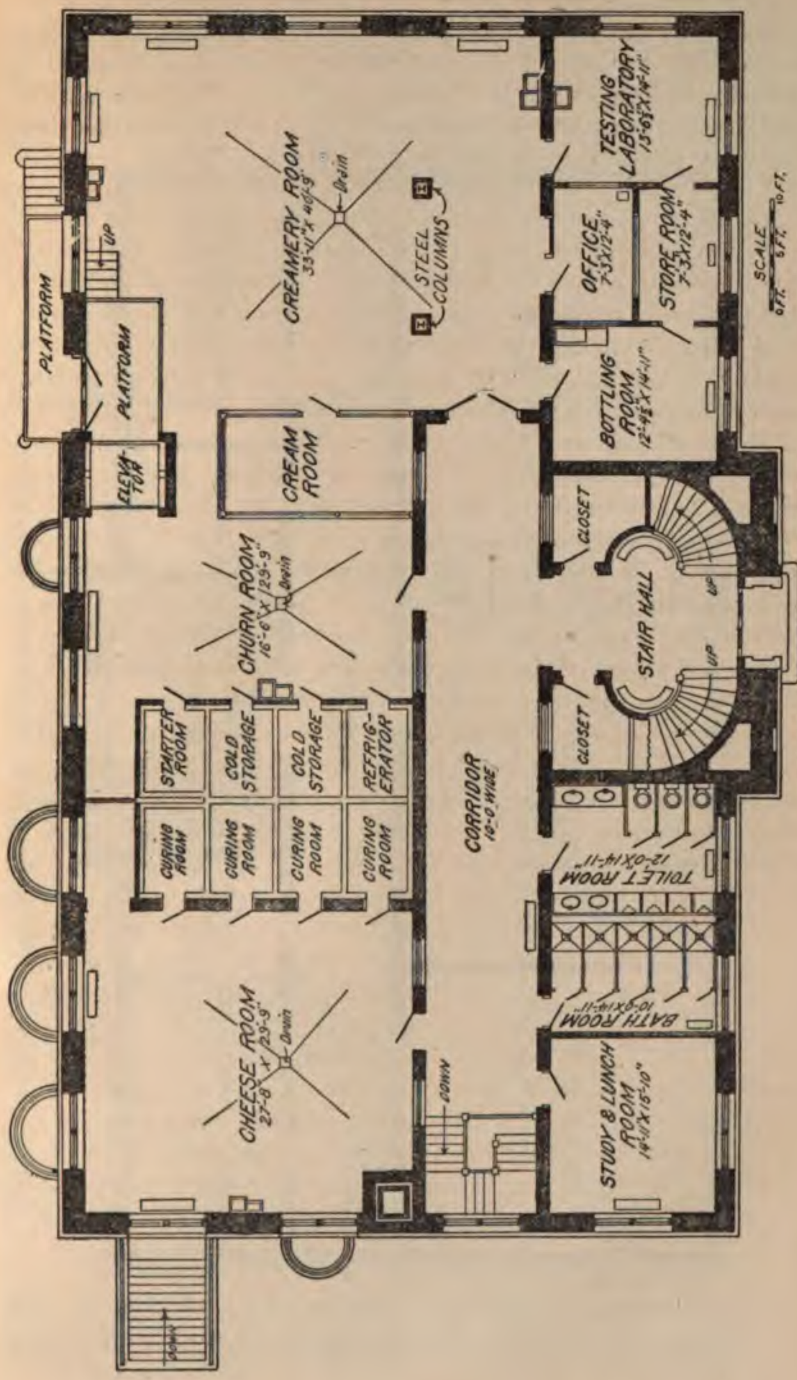


FIG. 9.—Ground-floor plan of dairy building, Iowa College.

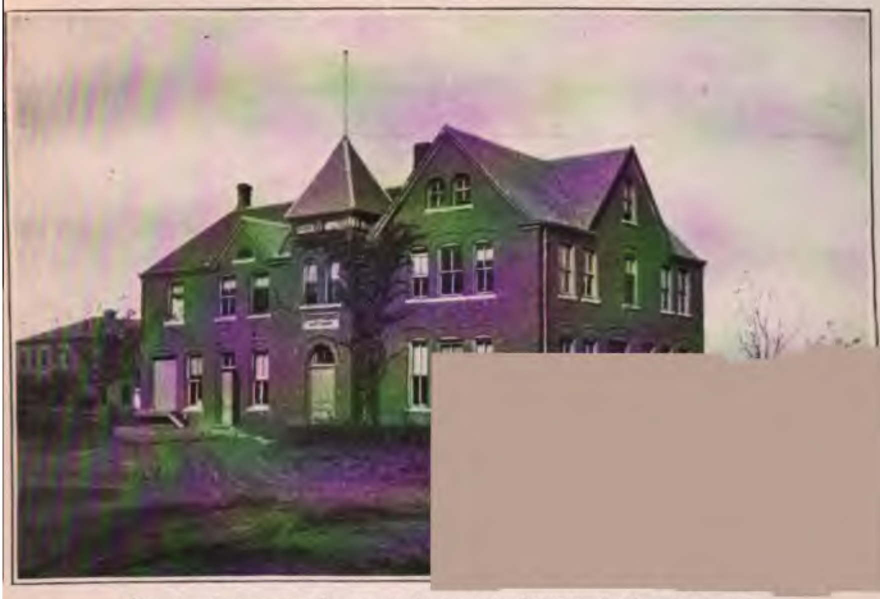


FIG. 1.—CREAMERY BUILDING, NEBRASKA SCHOOL OF AGRICULTURE.

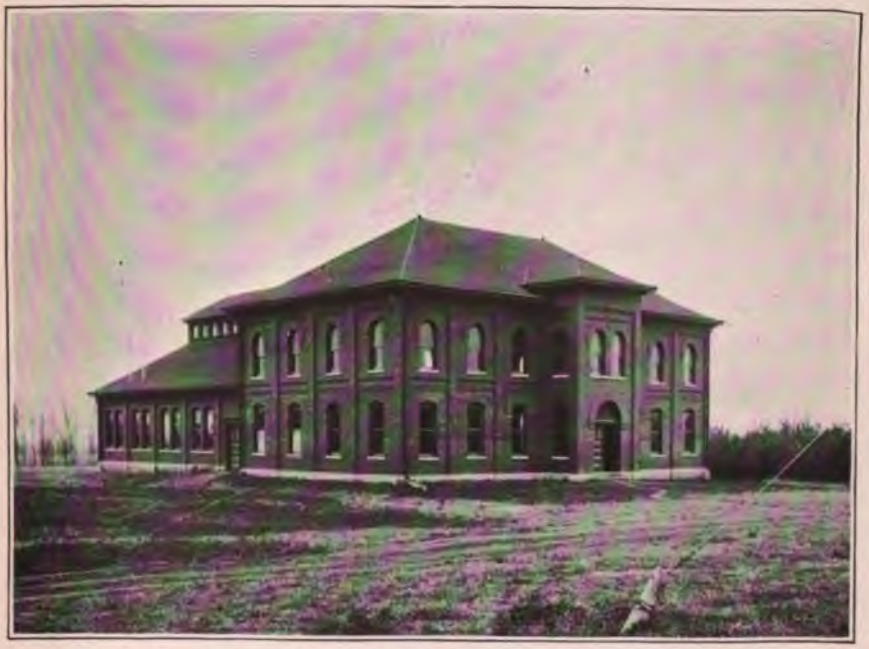


FIG. 2.—FARM ENGINEERING BUILDING, NEBRASKA SCHOOL OF AGRICULTURE.

house, 20 by 47½ feet, is used entirely as a greenhouse laboratory for instruction. (Pl. XXIX, fig. 2.) This has a 3-foot side bench built against the wall on either side, with a double row of students' work benches 3 feet 9 inches wide in the center, extending the entire length of the house and separated by a narrow passageway for the instructor. The students' benches are separated from the wall benches by a walk 2½ feet wide. Each student has a space 5 feet in length, from the side of which, next to the walk, a space 1 foot by 18 inches is removed to give standing room for the student, thus keeping the walk behind him open. The wall bench behind each student is used for his potted plants, stock for cuttings, etc.

The Nebraska School of Agriculture now has a commodious creamery building (Pl. XXX, fig. 1), and has recently occupied a new farm engineering building (Pl. XXX, fig. 2), which has been erected at a cost of $13,000 and provides facilities for instruction in blacksmithing, carpentry, and farm machinery.

## COURSES OF STUDY.

Graduate departments which afford opportunities for advanced degree work in agriculture are maintained by many of the colleges of agriculture. There are now 40 colleges which thus provide agricultural work leading to the master's degree and 9 which offer courses in agriculture leading to the doctor's degree.

The reorganization of courses of study and the division of agriculture into specialties along the lines recommended by the committee on methods of teaching agriculture have received increasing attention and are indications of progress in the development of the science of agriculture. The college of agriculture of Cornell University now offers regular four-year courses, which are very largely elective, special two-year courses in general agriculture and in nature study, and winter courses. The University of Maine has added a department of forestry to its agricultural work, and the University of West Virginia has organized a department of dairying in connection with the college of agriculture. The University of Missouri now has a new department, known as the Missouri Teachers' College, which proposes to give special attention to the training of teachers in agriculture.

### RURAL ENGINEERING.

The movement for the establishment of courses in rural engineering in the agricultural colleges is continuing, and the progress made in this direction was set forth in the report of the standing committee on rural engineering of the Association of American Agricultural Colleges and Experiment Stations at its annual convention at Des Moines, Iowa, in November, 1904, as follows:

Since the last meeting of the Association of Agricultural Colleges and Experiment Stations considerable progress has been made in the agricultural colleges in developing courses under the various names of agricultural engineering, rural engineering, and farm mechanics.

The agricultural colleges of Minnesota, Wisconsin, Illinois, North Dakota, Indiana, New York, Colorado, California, Kansas, Wyoming, and Iowa are now offering instructions to the agricultural students in the subject under one or the other of the above names. Minnesota has completed an inexpensive building which is devoted to the teaching of farm mechanics. Wisconsin has a large building under construction which is to be used for the same purpose. The Agricultural College at Cornell, N. Y., is planning a large and commodious structure to be devoted to agricultural engineering. Illinois has made considerable progress in its farm-mechanics course. During the last year the four-story fireproof farm-mechanics building at the Iowa Agricultural College has been completed, which, with its equipment, cost over $75,000, and a good course in farm mechanics is offered in the college curriculum. In this course during the spring term 125 students were enrolled.

In the Department of Agriculture progress has been made in recognizing the department of drainage in connection with the department of irrigation investigations.

It is to be regretted that a complete department of "irrigation and agricultural engineering" has not been established, which was last year suggested by the committee and recommended by the Secretary of Agriculture. The agricultural colleges that have established courses in farm mechanics have found that great interest is manifest in the work of studying the principles of construction and testing of farm implements. This is true not only of the students and the farmers, but also of the manufacturers of these farm implements, who realize the importance of this work and are offering friendly cooperation and assistance to the work.

An example of what may be accomplished for the benefit of not only the farmers but the manufacturers will illustrate the value of studying farm machinery in colleges. The farm-mechanics department of the Iowa State College undertook last year to test various makes of corn planters to note the accuracy of dropping the corn. It was found that there was considerable difference between the different makes and types of planters as to their accuracy of drop. The attention of the manufacturers was called to this fact, and while they were at first thoroughly convinced that their planters were accurate in their work, yet they found there was room for improvement, and two firms acknowledged that they improved the accuracy of drop of their planters 20 per cent after their attention had been called to the defects of the planters and a remedy suggested. By means of this cooperation with the manufacturers the farmers of the country are greatly benefited.

While the implement manufacturers of the country are no doubt seeking to bring out the best possible farm implements, yet their interests are from a purely business motive. The department of farm mechanics at the various colleges of agriculture and the Department of Agriculture can do much to further the improvement of farm machinery by making impartial tests and report on the defects to manufacturers. There is at the present time a great demand for information on the cost and efficiency of pumping machinery for irrigation purposes. The large projects of irrigation now under way in the Western States require the pumping of large quantities of water, to be lifted from 10 to 200 feet.

Thousands of acres of land on the Missouri slope in North and South Dakota can be irrigated if the water can be pumped from the Missouri River cheaply enough. Fuel is plenty in those sections of the country in the shape of lignite coal. The Department of Agriculture is performing a service of great value to the Western States by making experiments and collecting facts which will give information to settlers upon the best kind of pumping stations to install to supply the water for irrigation purposes.

During the last couple of years Germany, the Scandinavian countries, and Holland have issued several bulletins which give very interesting data upon tests made of domestic as well as American-made farm implements. These bulletins are of great value to those countries, giving, as they do, the cost of various implements, the amount of work that can be accomplished, and efficiency with which the different makes do the work. Germany has long recognized the value of agricultural and mechanical training both for the farm and for the factory. Our own manufacturers are anxious to obtain graduates from our agricultural colleges who have a knowledge of the requirements of agriculture, together with a mechanical training in the designing of farm implements. Several positions are now open for young men with training along these lines.

There are so many and varied subjects embraced in agricultural engineering that the subject is entitled to a more prominent rank than it now holds in our agricultural colleges. It ought to hold equal rank with the departments of dairying, animal husbandry, agronomy, and horticulture.

It is exceedingly important at this time that the Department of Agriculture take steps to organize a bureau or division of agricultural engineering, in order to aid the colleges which now have a course of agricultural engineering established, and to collect the data which such colleges are obtaining in their experimental tests for publication and distribution among the farmers; also to carry on original research and to establish laboratories for practical tests of implements, and a museum for farm implements.

The committee again recommends that the association declare itself in favor of the creation of separate departments of agricultural engineering in the colleges, that special efforts be made to assist the Secretary of Agriculture in his endeavor to extend the work along these lines, and that the executive committee use all means in its power to urge upon Congress the importance of this work and to convince them of the necessity of giving the Department liberal appropriations for these purposes.

Referring to this subject in his Annual Report for 1904, the Secretary of Agriculture pointed out the importance of studies relating to the construction and use of farm machinery:

The continued scarcity of farm labor in almost all of the agricultural regions in this country makes necessary the employment of farm machinery on even a more extensive scale than has hitherto prevailed. The total value of implements and machinery on farms in this country, according to the last census, was $761,261,500, an average of $133 per farm and of 90 cents per acre of farm land. Much of this machinery is elaborate and complicated in construction and requires mechanical skill and genius for its most efficient operation and care. In very many cases it is also essential that the farmer shall understand how to repair such machinery. It represents an important part of the farmer's invested capital upon which he must earn or pay interest. That there is an enormous waste of money due to neglect and unskillful handling of this part of the farm equipment must be obvious to any one who has traveled through the regions where it is most used. The colleges can therefore do a very important work in training their students so that they will understand the construction, care, and most economical use of farm machinery. * * *

I am of the opinion that results of great value, alike to the farmers and the manufacturers of agricultural machinery, will come from the extension of the Department's work in agricultural engineering to include studies of this character, in cooperation with the agricultural colleges and experiment stations. I have, therefore, asked Congress for an appropriation which will enable us to employ an expert in farm buildings and farm machinery in connection with the irrigation and drainage investigations.

The Rhode Island College of Agriculture and Mechanic Arts announced in 1904 for the first time a four-year course in highway engineering, "intended to meet a definite and growing demand for men competent to build better roads." This is probably the first course of the kind ever offered in an American college. The work for this course in the freshman year differs little from the other courses in mechanic arts at the college. In the sophomore year the student begins the study of elementary surveying in the spring term. At the beginning of the junior year he is required to reach the college about two weeks in advance of the opening term in September and devote this time to surveying, including all the usual operations of simple triangulation, topographical, railroad, and highway surveys. During the college year, in addition to English and mathematics, he will receive instruction in mineralogy and geology, with particular emphasis on road materials. Office work in platting and computation continues through the winter and surveys are completed in the spring. The senior year is given over largely to highway engineering proper, and includes the study of stereotomy, masonry construction, strength of materials, theory of road building, hydraulics, highway bridges, and field practice. The recitation and laboratory work will be adjusted to accommodate the practice in construction which may occur in the fall or spring term.

### RURAL ECONOMY AND SOCIOLOGY.

Increased interest is being manifested in the teaching of subjects included in rural economy and sociology in the agricultural colleges, as referred to in the report of this Office for 1903. To supplement the outline of a course of instruction in rural economy, given in that report, President Butterfield, of the Rhode Island Agricultural College, has prepared an outline of a course in rural sociology, which is as follows:

#### Outline for Proposed Course in Rural Sociology.

##### INTRODUCTION.

(1) Definitions.

(2) Relation of the sociological to the economic, the technical, and the scientific phases of agriculture.

### PART I.—THE RURAL SOCIAL STATUS.

Chapter 1.—Movements of the farm population.
- (1) Statistical survey.
- (2) The movement to the West.
  - History, causes.
- (3) The movement to the cities.
  - (*a*) Growth of cities.
  - (*b*) Depletion of rural population in certain localities.
- (4) Causes of the movement to the cities.
  - Industrial, social, and psychological causes.
- (5) Results of the movements of the farm population.
  - (*a*) Results both good and bad.
  - (*b*) Résumé of industrial and social results.

Chapter 2.—Social condition of the rural population.
- Nativity; color; illiteracy; families; health; temperance; crime; morality; pauperism; defectives; insanity; etc.

Chapter 3.—The social psychology of rural life.
- (1) Isolation and its results.
- (2) The farm home and its environment.
- (3) Traits of family life.
- (4) Traits of individual life.

Chapter 4.—The social aspect of current agricultural questions.
- (1) Tenant farming.
- (2) Large *v.* small farms.
- (3) Farm labor.
- (4) Irregular incomes.
- (5) Farm machinery.
- (6) Specialization in farming.
- (7) Immigration.

### PART II.—SOCIAL FACTORS IN RURAL PROGRESS.

Chapter 1.—Means of communication in rural districts.
- (1) Importance and status of rural communication.
- (2) The new movements for better rural communication.
  - (*a*) Highways.
  - (*b*) Rural free mail delivery.
  - (*c*) Rural telephone.
  - (*d*) Interurban electric railways.

Chapter 2.—Farmers' organizations.
- (1) Value of.
- (2) Difficulties in organizing.
- (3) Forms that organizations may take.
- (4) History and work of farmers' organizations in the United States.
- (5) General deductions from study of farmers' organizations.

Chapter 3.—Rural education.
- (1) Distinction between rural and agricultural education.
- (2) The country school.
  - (*a*) Its importance, organization, maintenance, instruction, and supervision.
  - (*b*) The rural school as a social center.
  - (*c*) The township unit, the consolidated school, the centralized school.

Chapter 3.—Rural education—Continued.
  (3) High school privileges for rural pupils.
  (4) The rural library.
  (5) Other agencies for rural education.
Chapter 4.—Means of agricultural education.
  (1) Historical.
  (2) Research in agriculture.
  (3) Agricultural instruction to resident students.
    (*a*) Higher education in agriculture.
    (*b*) Secondary education in agriculture.
    (*c*) Primary education in agriculture.
  (4) Extension teaching in agriculture.
  (5) Miscellaneous agencies for agricultural education.
    (*a*) Farmers' societies.
    (*b*) The farm press.
    (*c*) The country paper.
    (*d*) Industrial departments of steam railways.
Chapter 5.—The rural church.
  (1) Present status.
  (2) Difficulties in country church work.
  (3) The awakening in the rural church.
  (4) The institutional rural church.
  (5) The Young Men's Christian Association in the country.
  (6) The rural Sunday school.
  (7) The rural social settlement.
Chapter 6.—The social ideal for agriculture.
  (1) The importance of social agencies.
  (2) The preservation of the "American farmer" essential.
  (3) Relation of this ideal to our American civilization.
  (4) The federation or cooperation of rural social agencies.

The department of economics and sociology recently established by the Carnegie Institution, in charge of Carroll D. Wright, president of Clark University, has undertaken the preparation of an economic history of the United States, embracing eleven subjects. The second of these subjects, relating to agriculture and forestry, including public land and irrigation interests, has been assigned to President K. L. Butterfield, of the Rhode Island Agricultural College. This part of the work, it is understood, will be carried on with the collaboration of experts in various branches of agriculture.

### SHORT AND SPECIAL COURSES.

The popularity of the short and special courses of different kinds offered by the agricultural colleges is increasing. These include secondary courses, short winter courses, and summer schools. Already these courses are assuming such importance that the question is being raised in some quarters whether their establishments does not involve a serious departure from the legitimate field of the agricultural college, and whether therefore it would not be better that all these short and special courses should be given over to institutions specially organized for such work. At present, however, this movement in the colleges is extending and even reaches beyond the agricultural colleges.

Wellesley College announces a course in general horticulture and elementary landscape gardening. The course includes lectures on the preparation of soils, the propagation, cultivation, and pruning of plants, school gardens, and planting designs, and a brief consideration of the plants used in practical planting. The lectures will be supplemented by reading, work in the greenhouse, practice in making planting plans, practical work in the field, and visits to gardens, nurseries, and estates in the vicinity. The course covers one year, and includes three hours a week for that period. The college has also offered for a couple of years past a course in trees and forestry, covering one year, and including forest botany and sylviculture, the forests of the world, value and uses of their products, and the protection of wood lands.

Simmons College, Boston, offers a course in theoretical and practical horticulture designed to aid young women who wish to undertake the cultivation of flowers, fruits, and vegetables for commercial or other purposes. The course serves also as a practical basis for landscape gardening. It will extend over either three or four years, the first two years to be spent in Boston studying the underlying sciences and theoretical elements of horticulture, and the third year at the Massachusetts Agricultural College, as mentioned elsewhere.

Other colleges also are giving attention to the training of teachers for work in agriculture, nature study, and school gardening, largely through summer schools. Such schools have been in session this year at the agricultural colleges in Connecticut, Nebraska, and Tennessee; at the Hampton Normal and Agricultural Institute, Hampton, Va., and at the North Carolina College of Agriculture and Mechanic Arts. The attendance of teachers at the latter institution this year was 977, and about 500 of these took work in agriculture, nature study, and school gardening.

## EXTENSION WORK.

The agricultural colleges are reaching out more largely than ever before to give instruction to youth and adults through various forms of extension work. For a number of years the agricultural colleges and the experiment stations connected with them have done a large amount of such work through the farmers' institutes, for the maintenance of which in many States these institutions have been directly responsible.

Correspondence courses and reading courses for farmers, such as are conducted by the agricultural colleges of Pennsylvania, New

York, Michigan, South Dakota, and West Virginia, are valuabl features of the extension of these colleges.

A number of similar correspondence courses are also offered b private correspondence schools. Among such private schools ar those recently established by the Columbian Correspondence College of Washington, D. C., which announces 14 courses in agricultur under the direction of experts of the U. S. Department of Agriculture; the Correspondence College of Agriculture, recently organized at Sioux City, Iowa, which offers courses of study in anima husbandry, agronomy, and veterinary science, under the direction o professors of the Iowa Agricultural College, and the Home Correspondence School, of Springfield, which has been conducted for number of years by the King Richardson Company, but has onl recently been incorporated under the laws of Massachusetts as a independent institution.

Another feature of the extension work in agriculture is the specia publication or bulletin, such as the nature-study bulletins and school garden bulletins issued from the agricultural colleges in New York Indiana, Rhode Island, Michigan, New Hampshire, and Washington, and from the negro institutions at Hampton and Tuskegee. Th Ohio State University, the University of Missouri, and the University of Minnesota have issued a number of agricultural bulletin for use in rural schools or intended to promote the teaching of agriculture in rural schools.

Another way of extending the influence of the college among th people is through the student unions and the experiment unions such as are organized in Ohio, Wisconsin, Illinois, Iowa, and New York. There are also in New York, Ohio, Illinois, Iowa, and Texa experimental or agricultural clubs of boys and girls, which hav been organized largely through the instrumentality of the agricultural colleges for the purpose of arousing among the young peopl an interest in the study of agriculture and in improved methods o doing farm and household work.

A new feature of extension work in agriculture undertaken by th agricultural colleges in Iowa, Nebraska, and Missouri is the dissemination of information regarding better methods of agricultur through exhibits placed in railroad cars and taken on special train to many localities. Instructors from the agricultural college accompany these trains to explain the exhibits whenever the train stops, an distribute publications to the farmers who assemble at the depot Prof. P. G. Holden, of the Iowa Agricultural College, has given a account of this work in Iowa in the Review of Reviews for November 1904, from which the following statements are taken:

> In the spring of 1904 it appeared from tests made at the Iowa Agricultura College that on an average only 63 per cent of seed corn ordinarily used b

farmers was worth planting. To call wide attention to this fact and show how such a serious difficulty could be corrected, special trains were run on two railroad systems in the State. Handbills were placed in every station, and the agents were instructed to notify the farmers of the "seed-corn special," and to urge them to attend the meetings at the stations on schedule time. Letters were sent to grain dealers along the line asking them to notify their patrons personally or by telephone of the purpose of the meetings, and local papers were especially effective in spreading the news.

Talks from twenty to thirty minutes were given at each station. As many farmers were admitted to the cars as they would hold, but it was "usually necessary to open the car windows and allow those on the outside to hear the lectures, although they could not see the illustrative material within."

Many teachers attended the lectures, and one of the far-reaching results was that they had their pupils bring corn from home for testing, and had them prepare the tests and carry the results home to the parents, thus giving a practical "nature lesson" that applied directly and vitally to the interests closest to their daily lives.

In eight days the "seed-corn special" trains covered 1,321 miles, and passed through 37 of the 99 counties of Iowa. One hundred and fifty talks were given to 17,600 farmers, representing 1,500,000 acres of corn, or an average annual yield of 55,000,000 bushels, worth $18,000,000, and the press carried the information to every farmer and landowner in the State.

So broad has the extension work of some institutions become that there is now a movement for the establishment of separate departments of extension work which, to a considerable extent at least, will have a separate corps of officers and instructors. It seems very desirable that this extension work should be more definitely organized and put upon its own footing in order to relieve the pressure for such work, which now rests too heavily on the regular faculty of the college and the staff of the experiment station.

## THE SECONDARY SCHOOLS.

Progress has been made during the year along lines of secondary instruction in agriculture not only in the schools maintained in connection with the agricultural colleges, but also in the separate secondary schools. The nine district agricultural schools in Alabama are now regularly inspected by the State commissioner of agriculture, and it is proposed to give more attention to the agricultural courses in these schools.

The Girls' Industrial College, which was opened at Denton, Tex., in September, 1903, will give considerable attention to the teaching of horticulture and ornamental gardening. This is provided for in the department of rural arts, which will embrace floriculture, horticulture, truck and berry growing, dairying, bee keeping, and poultry keeping. The campus of about 70 acres will be devoted largely to landscape gardening and forestry.

A four-year agricultural course is now offered by Union Academy, Belleville, N. Y. This is done at the request of George and William W. Mather, who in 1901 gave Union Academy $10,000 for the support of a school of agriculture. The course in agriculture includes two terms each of instruction in drafting plans for farm buildings, entomology, soils and fertilizers, horticulture, plant life, economics of agriculture, animal husbandry, poultry keeping and zootechny, and one year of agriculture (agronomy). Lyman Carrier, who had charge of chemistry and agriculture in the Elyria, Ohio, high school last year, has been elected vice-principal of Union Academy and will teach science and agriculture.

The ten county normal training classes provided for by the last legislature of Michigan have been located by the State superintendent of public instruction in the following towns: Evart, Charlevoix, Cadillac, Standish, Kalkraska, Mancelona, Ithaca, Pontiac, St. Johns, and Port Huron. One-year and two-year courses are provided, and in the course of study suggested by the superintendent of public instruction elementary agriculture is required in both semesters of the one-year course and the first year of the two-year course and is elective throughout the second year of the two-year course. Applicants for admission to either of the courses must subscribe to a declaration that it is their purpose to engage in teaching in the rural schools or in the lower grades of the graded schools in the State.

The progress made in the county agricultural schools in Wisconsin is described elsewhere in this report by the principal of one of the schools.

The State board of agriculture of Missouri has recently appointed a standing committee on agricultural education, whose aim is to be the bringing about of the establishment of county or district agricultural high schools in that State.

## THE PRIMARY SCHOOLS.

At the annual convention of the Association of American Agricultural Colleges and Experiment Stations at Des Moines, Iowa, in November, 1904, the standing committee on methods of teaching agriculture made a report in which it gave a brief history of the development of manual training and agricultural instruction in the common schools and outlined a course of nature study and elementary agriculture for such schools. This report is as follows:

In accordance with the apparent wishes of the association as expressed in an informal discussion of the report of this committee, at the meeting in Washington last November, this ninth report of the committee on methods of teaching agriculture is devoted to a discussion on the feasibility of teaching agriculture in the rural common schools, and suggestions regarding the nature and extent of such teaching. In this discussion the term "common schools" is taken to mean schools giving instruction in grades below those of the high school, and the term "rural schools" will include not only the schools in extremely rural districts, but also those in villages and small towns which draw largely on the adjacent country for pupils and financial support. It should also be understood that in this report attention is confined to matters relating to the teaching of agriculture in the rural schools as ordinarily organized in our public school system. We have not undertaken here to discuss the advisability of the establishment of county or district elementary schools of agriculture as separate institutions or the courses of instruction suitable for such schools.

## DEVELOPMENT OF INDUSTRIAL TRAINING IN THE COMMON SCHOOLS.

Industrial training as a subject for regular instruction in the common schools has been until recently confined largely to manual training in the city schools, and even in these schools it is still far from being fully developed. However, the number of schools in which manual training (other than drawing) is given has increased rapidly during the past thirteen years. In 1890, when the Bureau of Education first began publishing the statistics of manual training in the United States, there were only 37 cities of 8,000 population and over, in which manual training was taught in the public schools; in 1902 there were 270 such cities. The schools referred to are those in which other subjects than manual training are mainly taught.[a] In 25 of these schools manual training is given in all grades, including the high school; in 64 it begins with the first grade; in 33 it is confined to the high school, and in 206 (more than three-fourths of all the schools) it is given in some of the grammar grades.

The introduction of manual training into courses of study which were already crowded has involved problems requiring close and careful study of the needs of the pupils, and has generally resulted in greatly increasing the efficiency of the schools in which manual training is now taught. The effort has been made to retain all the essentials of the branches commonly taught in such schools and add the manual training. This has been done by a careful grading of the pupils, by securing better teachers and text-books, and by judicious and careful elimination of the nonessentials in the various branches.

The time to be given to manual training, so that it will not interfere with efficient instruction in other branches, has been carefully considered, and experiments with regard to this have been tried. Some idea of the time occupied by manual training in some of our larger cities can be gained from the following statements: In Boston 2 hours per week are devoted to manual training throughout the fourth to ninth grades, inclusive, the boys having drafting, woodworking, and clay modeling, and the girls sewing and cooking. Manual training in the schools of New York City extends through seven grades, with a total of 4 hours per week for both boys and girls during the first 5½ years, and 4½ hours during the second half of the sixth year and all of the seventh year. In the seventh and eighth grades of the Washington schools the girls have one two-hour exercise a week in cooking and sewing, and the boys a similar period in woodworking. In Allegheny the boys have shopwork 2½ hours and drawing 1½ hours a week for three years, and a supplementary course of one year. In Toledo each ward school has one manual training period of 1½ hours a week.

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[a] There were also in 1902 163 schools devoted chiefly to manual and industrial training.

The time devoted to manual training in Los Angeles is two 20-minute periods a week through the first four grades and three 25-minute periods throughout the next four grades. The work includes paper folding and cutting, raffia work, reed basketry, cardboard construction, sloyd, drawing, shop practice, sewing, and cooking. In San Francisco manual training for boys includes one lesson per week of 50 to 60 minutes in the seventh and eighth grades. Comparatively few of the schools having manual training give less than an hour a week to this work, and the great majority allow two or more hours for it. In most cases the work extends over three, four, or more years. The average cost of the plant for manual training in the 270 cities reporting work of this kind in 1902 (not including manual training high schools) was $20,000, making a total investment for this purpose of $5,400,000. The current expenditures for teachers, materials, tools, etc., in 1901–2 were nearly $1,000,000.

### MOVEMENT TO INTRODUCE AGRICULTURE INTO THE RURAL SCHOOLS.

More recently there has developed a movement to introduce the elements of agriculture into the rural schools. This movement has been largely an outgrowth of the nature-study movement which for a number of years has been encouraged by such agencies as the Cornell University Bureau of Nature Study and the agricultural colleges in a number of other States, as well as by many prominent educators connected with other kinds of schools and colleges. Then came the school-garden movement, and in this as in the nature-study movement the city schools have led those in the country, partly because the children in the city schools have taken a greater interest in such work on account of its novelty to them, and partly because the city schools through better organization and equipment and special teachers have been able to make experiments of this kind more readily than the rural schools. In these experiments, as might have been expected, mistakes were made. Nature study, according to some of its advocates, was to be elementary science, with a long list of scientific names, with classifications based on stipules, scales, and caudal appendages, and with a "why" for everything. It involved such a universal knowledge of science that teachers were appalled at the prospect of having to prepare for the innovation. On the other hand, some of the advocates of nature study would have no formality, no classification, no plan—whatever came to hand was a subject for nature study. Facts were to be learned, not because of any bearing that they might have upon the symmetrical development of the children's faculties, but simply because they were interesting. There was no logical beginning to such study, no pedagogical sequence, no end. Fortunately there were other teachers and students of education who took neither of these extreme views, but who saw in nature study an opportunity to bring the children into more sympathetic and helpful relations with their natural environment, and at the same time increase their fund of useful knowledge. These teachers, when located in city schools, have brought to the consideration of their nature-study classes the trees, shrubs, flowers, and vines found around the city homes, in the parks, and in the lawns, and have studied the insects, birds, and other animal life of the city in relation to this plant life. In the country they have considered the plants, animals, birds, and insects which surround the farmer and aid or hinder him in his work, giving much attention to their economic importance and very little to any marked peculiarities they might chance to possess. Such nature study forms an excellent basis for the subsequent study of more formal agriculture. It has been tried in both city and country schools, and has been found to furnish not only a means for arousing and sustaining the interest of the children, but also, through its economic limitations, an outline sufficiently definite to enable the teacher to know where to stop and yet sufficiently flexible to enable her to adapt it to local conditions.

Nature study such as this, having an agricultural trend, is about all that has been attempted in the way of teaching agriculture in the rural schools until quite recently. Within the past two or three years, however, State superintendents of public instruction, the officers of some of the agricultural colleges, the National Educational Association, the American Civic Association, as well as a number of other organizations and numerous individuals in various official positions, have interested themselves in the introduction of elementary agriculture and gardening in the rural schools. The National Educational Association now has a special committee of educators of national repute considering this subject. The American Civic Association has one department devoted to children's gardens and another to rural improvement. Last June, in Chicago, an organization known as the American League of Industrial Education was organized to "conduct an educational campaign for an industrial public school system which should include the teaching of domestic science, and both agricultural and manual training in all public schools; * * * to promote the establishment of school gardens in connection with all public schools, where every child would be taught to be a lover of nature and of the country, and trained toward the land as a source of livelihood rather than away from it; * * * to advocate the establishment of public manual training school farms in every county in the United States, and of as many such manual training school farms in the vicinity of all cities by State, municipal, and national governments, as may be necessary to give to every boy the opportunity to learn how to earn his living by his labor and to till the soil for a livelihood and get his living from the land."

Some of the State school authorities, officers in agricultural colleges, and county superintendents of schools have prepared outlined courses in agriculture which have exerted a strong influence toward the teaching of agriculture in the rural schools. Such courses have been prepared, for example, in Missouri, Illinois, and Indiana, and for a group of schools under one superintendent in Durham, N. H., and vicinity.

The Illinois course in agriculture was prepared by the dean of the college of agriculture, and gives the following reasons for teaching agriculture in the public schools:

"(1) To cultivate an interest in and instill a love and respect for land and the occupation of agriculture.

"(2) To create a regard for industry in general and an appreciation of the material side of the affairs of a highly civilized people.

"(3) To cultivate the active and creative instincts as distinct from the reflective and receptive that are otherwise almost exclusively exercised in our schools.

"(4) To give practice in failure and success, thus putting to the test early in life the ability to do a definite thing.

"(5) To train the student in ways and methods of acquiring information for himself and incidentally to acquaint him with the manner in which information is originally acquired and the world's stock of knowledge has been accumulated.

"(6) To connect the school with real life and make the value and need of schooling the more apparent.

"(7) As an avenue of communication between the pupil and the teacher, it being a field in which the pupil will likely have a larger bulk of information than the teacher, but in which the training of the teacher can help to more exact knowledge."

The course is arranged by months and gives suggestions for a large number of experiments and observations bearing on all the divisions of agriculture. Considerable reading along agricultural lines is suggested, as well as drawing, composition, and other work intended to correlate agriculture with other school work. All technical words likely to be used frequently in this connection are defined.

This course has been in the hands of Illinois teachers one year, and the superintendent of public instruction reports "an increased interest throughout the State in the study of agriculture." He says:

"In nearly every county in the State a good beginning has been made, and in several counties the interest and progress has been little less than remarkable. In many rural schools the subject is being studied following the outline found on pages 166–180 of the Illinois Course of Study for the Common Schools. Some of the graded schools are doing systematic and intelligent work along this line and are conducting in connection with the schools successful school gardens. That the interest is growing is shown by the many thousand requests for corn and seeds which are received by the secretary of the farmers' institute."

According to statistics collected by the superintendent of farmers' institutes in Illinois, fourteen counties report that in nearly all the schools agriculture is being taught as suggested in the State course of study, and in fifteen other counties a majority of the schools are attempting this work.

In addition to agricultural work in the schools of Illinois, considerable is done by the State College of Agriculture, the superintendent and the secretary of farmers' institutes, and county superintendents of schools to arouse an interest in farm life by menas of clubs of farmers' boys, which are organized in the different counties for the purpose of conducting experiments at their homes in testing improved varieties of corn and sugar beets. These clubs hold regular meetings similar to farmers' institutes, and once a year are given places on the programmes of the county farmers' institutes. Several of these clubs have had lecture courses with lectures from men prominent in the agricultural colleges and experiment stations, and some of them have gone on excursions to different agricultural colleges. Eight thousand of these boys exhibited corn of their own raising at the Louisiana Purchase Exposition, and 1,250 of them drew prizes ranging from 50 cents to $500. The girls have similar organizations which are devoted to the consideration of subjects relating to the farm home.

Similar organizations of boys and girls are also found in Iowa, Ohio, and Texas, all of them organized under the auspices of the State agricultural colleges or of agricultural journals. The membership of the boys' and girls' clubs in Ohio is nearly 2,000 and in Texas over 1,200, though the latter organizations are little more than a year old. Everywhere that work of this kind has been done it has seemed to meet with enthusiastic approval. The boys and girls take pride in their organizations and in doing in a small way what their parents do more extensively.

In Missouri the course in agriculture for the public schools was prepared several years ago by the State superintendent of schools. This course has been superseded by a bulletin prepared by the State superintendent of schools and published by the Missouri State board of agriculture in September of the present year, entitled Elements of Agriculture for the Public Schools. This bulletin advocates presenting the subject of agriculture "(1) by experiments at home and in the field, (2) by studying facts as given in texts and bulletins, and (3) by school gardens connected with school grounds."

"Teachers are advised to utilize school grounds or gardens near the school as experiment stations, to have pupils experiment at home and make field observations, and to secure bulletins from the Department of Agriculture, at

Washington, D. C., from the Missouri State board of agriculture, and from the agricultural college, both at Columbia. The school library should have copies of several good texts. Appeal to the pupils' interests along all lines, and enlist the cooperation of the parents."

The course in agriculture, as outlined in the bulletin, includes (1) studies on soil—origin and composition, kinds, plant food, improvement, rotation of crops, and experiments; (2) roads—value of good roads, road drainage, artificial roads, good dirt roads, influence of roads, road laws, and experiments; (3) studies on seeds and related subjects—germination, vitality, and parts of seeds, with experiments in corn planting, corn growing, corn judging, selecting seed corn, and observations and experiments with corn (similar treatment of wheat); (4) studies of plants—their classification, relation to soils, buds, twigs, etc.; (5) orcharding and gardening—apples, grapes, berries, home gardening, commercial gardening, enemies to gardens; (6) study of insects; (7) stock raising and feeding—horses, mules, cattle, sheep, hogs, and domestic fowls. Numerous experiments and observations are suggested throughout the bulletin. Two bulletins have also been issued by the College of Agriculture of the University of Missouri which are intended for use in the public schools. One of these is on plant propagation and the other on the principles of plant production—the seed.

The superintendent of public schools, the College of Agriculture, and the State normal schools in Missouri are cooperating in agitating the introduction of agriculture into the public schools throughout the State. This is done by addressing teachers' institutes, farmers' institutes, and other public meetings; by conducting summer schools for teachers at the College of Agriculture, in which special attention is given to courses which will prepare them for teaching agriculture; and by conducting regular courses in agriculture at the three State normal schools.

The State superintendent of public instruction of Indiana, in his State Manual and Uniform Courses of Study for the Elementary Schools of Indiana, 1904–5, includes a nature-study course intended "to acquaint the pupil with his environment and to train him to see and understand the relationship and meaning of common things," and a course in elementary agriculture. The subjects suggested for consideration in the nature course are largely the plant and animal life of the farm and the garden. The course in agriculture is simply an outline intended to guide the teacher, taking up for first consideration plant and animal products; then the soil, its formation, nature, tillage, and enrichment; and, finally, plant life. References are given to a number of bulletins and elementary text-books of agriculture.

The department of agriculture of the University of Minnesota has been actively engaged in promoting the teaching of agriculture in the rural schools, and its officers have prepared a bulletin on Rural School Agriculture for the use of the teachers in that State. In Wisconsin the State superintendent of the public schools and the officers of the College of Agriculture of the University of Wisconsin have done much for the introduction of agricultural teaching in the country. One of the results of their efforts has been the enactment of a law requiring teachers to pass examinations in agriculture. Similar laws have also been enacted in Maine, Nebraska, North Carolina, South Carolina, and Tennessee.

The training of teachers along agricultural lines is receiving considerable attention not only in Missouri, as mentioned above, but also in other States. The College of Agriculture of Cornell University now provides a two-year normal course in nature study and gardening. In Michigan ten county normal training schools have recently been opened for the purpose of training teachers for the rural schools. The course of study recommended for these normal schools by the State superintendent of public instruction includes agriculture. The agricultural colleges in Connecticut, Nebraska, and North Carolina have for a number of years conducted summer schools for teachers, at which more or less attention has been given to nature study and agriculture. At the Nebraska summer school in 1904 there were 23 students in nature study and 30 in agriculture. At the North Carolina summer school for teachers in 1904 there were enrolled 977 teachers, of whom 477 took work in agriculture. The summer school of the South, conducted at the University of Tennessee, with an annual attendance of from 1,000 to 1,300 teachers from all parts of the South, gives considerable attention to nature study and gardening.

One thing that has given a great impetus to the movement for the introduction of agriculture into the public schools has been the improvement of text-books and works of reference. Within the last year or two a number of elementary text-books in agriculture have been published, and some of these seem very well suited to use in the rural schools. One of the indirect results of the appearance of these text-books has been legislation in a number of States requiring the teaching of agriculture in all the rural schools, and adopting text-books for that purpose. State adoption of text-books in agriculture has been made in Alabama, Georgia, Louisiana, North Carolina, and Tennessee. Every city and county in Virginia, a majority of the counties in Maryland, about 15 counties in California, and a number of counties in Florida have also adopted text-books in agriculture for regular use in the public schools. It is estimated from teachers' reports that at least 12,000 children received instruction in agriculture in North Carolina last year. Thus it will be seen that there is quite a strong movement for the introduction of agriculture into the rural schools and that this movement is rapidly gaining momentum.

### OBSTACLES TO THE GENERAL INTRODUCTION OF AGRICULTURE INTO THE RURAL SCHOOLS.

There are many things which have a tendency to hinder the rapid progress of this movement. One of these is the conservatism or apathy of school officers. This applies not only to local officers, but also to State superintendents of public instruction, county superintendents of schools, and the officers of agricultural colleges in many of the States. Some of these officers doubt the possibility or wisdom of teaching agriculture in the common schools on account of the lack of text-books, or the lack of trained teachers, or for some other reason. It is, however, a notable fact that in the States where such officials are cooperating actively and earnestly in conducting a lively campaign along these lines, agriculture is actually being taught with considerable success, and teachers who feel that they are unprepared in this branch are flocking to summer schools where they can make the necessary preparation.

Another difficulty is that the teachers in rural districts are mostly women with little or no normal training, either in the ordinary branches taught in the common schools or in special subjects. There is no teaching profession in the rural schools. The salaries are so low that they do not attract those who have prepared themselves for the profession of teaching. As a consequence, most of the teachers found in rural schools are beginners or those who have not been sufficiently successful to be called to positions offering a higher salary. Most of the men who are teaching in the country are doing so merely for the purpose of raising money to go away to school or to go into business.

These conditions result in a rapid shifting of teachers from school to school, which is another serious drawback to progress of any kind. Again, the terms of school are too short. When a child can go to school only four or five months in the year there is little time in the few years that he is in school for the study of other subjects than reading, writing, arithmetic, geography, and history. Before much progress can be made in the introduction of agriculture into the rural schools much must be done for the general improvement of those schools. This improvement will be brought about partly by remedying the conditions already mentioned in the school districts as they are now organized, and partly through the consolidation of small districts and the organization of centralized schools, including rural high schools where village high schools are not readily available for those who can go beyond the grammar grades. The practice of consolidating schools has already been resorted to in California, Colorado, Connecticut, Florida, Georgia, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Vermont, Washington, and Wisconsin. Notable movements toward the consolidation of schools have recently been inaugurated in Louisiana, Missouri, and North Carolina. While this movement toward consolidation has spread to all parts of the country, there are relatively few localities in any State in which the system has been adopted and brought into working order. Hence the full effect of this important change in school policy has not been felt, even in the States where consolidation is a feature.

In the localities where consolidation has been thoroughly tried, however, it has usually met with general approval. It has enabled the school officers to grade the schools more effectually, thereby opening the way to greatly enriched courses of study; to lengthen the term of school; to employ better teachers at higher salaries and keep them for a number of years, and to employ several teachers instead of one, each to give instruction in only a few subjects or to only two or three grades, thereby opening the way to the more continuous and profitable employment of the pupils' time. It is notorious that in the ordinary country school where the teacher has from 25 to 30 recitations in a day and can not personally direct the study of the children, the latter waste fully half of their time in idleness or mischief-making. This and many other defects of the rural common school are remedied by consolidation, and the transportation of pupils from distant parts of the district at public expense is accomplished at no additional expense per unit of attendance. The Commissioner of Education in his annual report for 1903 says: "The possibilities of consolidation in the way of furnishing better and cheaper schools have been fully demonstrated, and such being the case its general adoption would seem to be only a question of time."

While consolidation opens the way for the more general introduction of courses in agriculture in the rural schools, it does not help supply the demand for teachers competent to give such special instruction. This can only be done by a more general and concerted effort on the part of the agricultural colleges and schools and the State normal schools, at present through the introduction of short and special courses in agriculture for teachers and later through regular normal courses in agriculture.

Fortunately, the attention of the general school officers throughout the country is now being strongly drawn toward the needs of the rural schools, and in many States strenuous efforts are being made to improve the general condition of these schools. Our urban communities are coming to see more clearly that their prosperity is vitally associated with the prosperity of agriculture, and they therefore more readily assent to State taxation for the benefit of the rural as well as the city schools. Advantage should be taken of the increased prosperity of many of our agricultural regions to impress upon our farmers the wisdom of building better schoolhouses, improving the school grounds, increasing the pay of teachers, and introducing the teaching of agriculture in the country districts, as an investment which will greatly aid in perpetuating and increasing the prosperity they now enjoy, and make the lot of their descendants more fortunate than their own. The agricultural colleges and the farmers' institutes can have great influence in this direction.

### OBJECT OF TEACHING AGRICULTURE.

Coming now to consider what should be the aim of instruction in agriculture in the elementary school and how it should be related to the general scheme of elementary education as formulated and approved by educational authorities, we have for our guidance the report of the committee of fifteen of the National Educational Association. In this report it is assumed and argued that the studies of the school fall naturally into five coordinate groups: (1) mathematics and physics; (2) biology, including chiefly the plant and the animal; (3) literature and art; (4) grammar and the technical and scientific study of language; and (5) history and the study of sociological, political, and social institutions. Dr. W. T. Harris, United States Commissioner of Education, in a paper discussing this report and the necessity for five coordinate groups of studies in the schools, says:

"Each one of these groups, it was assumed, should be represented in the curriculum at all times by some topic suited to the age and previous training of the pupil."

Continuing, he says:

"The first stage of school education is education for culture, and education for the purpose of gaining command of the conventionalities of intelligence. These conventionalities are such arts as reading and writing and the use of figures, technicalities of maps, dictionaries, the art of drawing, and all of those semimechanical facilities which enable the child to get access to the intellectual conquests of the race. Later on in the school course, when the pupil passes out of his elementary studies, which partake more of the nature of practice than of theory, he comes in the secondary school and the college to the study of science and the technic necessary for its preservation and communication. All these things belong to the first stage of school instruction whose aim is culture. On the other hand, post-graduate work and the work of professional schools have not the aim of culture as much as the aim of fitting the person for a social vocation. In the post-graduate work of universities the demand is for original investigation in special fields. In the professional school the student masters the elements of a particular practice, learning its theory and its art.

"It is in the first stage, the schools for culture, that these five coordinate branches should be represented in a symmetrical manner. It is not to be thought that a course of university study or that of a professional school should be symmetrical. But specializing should follow a course of study for culture in which the symmetrical whole of human learning and the symmetrical whole of the soul should be considered. From the primary school, therefore, on through the academic course of the college, there should be symmetry and five coordinate groups of studies represented at each part of the course—at least in each year, although perhaps not throughout each part of the year."

Discussing the second coordinate group, the biological, Doctor Harris argues that it should include "whatever is organic in nature—especially studies relating to the plant and the animal—the growth of material for food and clothing, and in a large measure for means of transportation and culture. This study of the organic phase of nature forms a great portion of the branch of study known as geography in the elementary school."

While it is probably true that eight years ago, when this was written, geography as taught in the primary grades of the best city schools included all the studies relating to the plant and the animal that were at that time considered necessary, it is also true that at the present time much of this study is introduced under the term "nature study," and the child's knowledge of the phenomena of plant and animal life is much clearer and more definite by reason of the concrete methods employed in nature study.

In the average village and rural school nothing approaching adequate instruction in the biological group of studies has ever been given. Geography, as far as taught in the primary grades, has consisted almost entirely of text-book work and has had in it very little that is concrete or that touches the experience of the child. Nature study, on the other hand, begins with the concrete—with the organic life of the school yard, the garden, and the farm. It has therefore a very definite and useful place to fill among the culture studies, particularly the biological studies of the primary grades. Elementary nature study, together with an informal study of local geography, might well supersede the formal study of geography during the first three or four years. This should be followed by more formal geography and nature study, the latter to be superseded by the elements of agriculture when the child is eleven or twelve years old.

Agriculture should not be confused with manual training as taught in the city schools. Manual training "relates to the transformation of materials, such as wood or stone or other minerals, into structures for human use," and draws more from the mathematical group of studies than from the biological. Agriculture, on the other hand, is confined mainly to things biological. Its purpose in the common schools is to awaken an interest in the work and life of the farm, show the progress being made in the improvement of farming, indicate the rational and scientific basis of modern agriculture, and give the pupil an outlook toward the work of the experiment stations, agricultural schools and colleges, and other agencies for his future education or assistance in his life work.

The motive for teaching agriculture in the rural school may, however, to a considerable extent be the same as that for manual training in the city school—namely, to bring the child into direct and sympathetic relations with the industrial life of the community in which he lives. Undoubtedly, manual training in the city school has an outlook toward the shop, factory, and kitchen, and in the same way agriculture in the rural school should be directly related to the practical work of the farm.

## A REASONABLE PROGRAMME FOR AGRICULTURAL TEACHING IN THE RURAL COMMON SCHOOLS.

Whenever it is proposed to introduce the teaching of agriculture into the rural common schools the objection is at once raised that the curriculum is already crowded; there is no time for more. This is true. There is no time for more, but there is time for better. It would be undesirable and unwise to do away with any of the studies now regularly taught in the common schools, but it would be wise to make a more judicious selection of the topics to be included in the courses in the various branches and omit much which now occupies the time of the pupils but which is not likely ever to be of use to them. Prof. Frank M. McMurray, of the Teachers' College of Columbia University, in a recent article discussing Advisable Omissions from the Elementary Curriculum and the basis for them,[a] says: "Life is too full of large specific ends to be attained to allow time for work that has no really tangible object." As a basis for the rejection of subject-matter from school courses he holds to the following propositions:

"(1) Whatever can not be shown to have a plain relation to some real need of life, whether it be æsthetic, ethical, or utilitarian in the narrower sense, must be dropped.

"(2) Whatever is not reasonably within the child's comprehension, likewise.

"(3) Whatever is unlikely to appeal to his interest; unless it is positively demanded for the first very weighty reason.

"(4) Whatever topics and details are so isolated or irrelevant that they fail to be a part of any series or chain of ideas, and therefore fail to be necessary for the appreciation of any large point. This standard, however, not to apply to the three R's and spelling."

He does not favor the entire omission of any subject now taught in the elementary schools, but does recommend the omission of particular topics and details. Omission, however, is not the only remedy that he suggests for the crowded condition of the elementary school curriculum. In the last paragraph of this article he says:

"In conclusion, although some large topics should be omitted, reform in the main is not to be effected by lopping off here and there, but by changing the present aggregation of ideas in each study to an organized body of thought. It is not the task of grade teachers nor of scientists, but of the most advanced and ablest students of education, who are as well posted in subject-matter as in the principles of education itself. Even these have more than a life problem in such a task."

It is along lines such as these that the curriculum of the rural schools may be so far improved that there will be ample space for the teaching of agriculture in an effective way. Just as the courses in the city schools have been improved and enriched by the introduction of manual training, so the teaching of agriculture in the rural schools, when once parents and teachers are convinced of its importance and benefits, will be found to be both practicable and advantageous.

In a rural school having a curriculum extending over about eight years the courses in nature study might follow in a general way the brief outlines given below. In these outlines it is assumed that the nature study courses will extend over about six years, and be followed by a course in agriculture extending over two years.

### NATURE STUDY.

During the first two or three years in school the children should spend a short time each week in forming an acquaintance with the birds, insects, flowers, trees, and other animal and plant life of the schoolyard, the roadside, and the wayside pastures and woodlots. This very pleasant and profitable way of gaining knowledge has been their principal occupation during the two or three years that they have been running about out of doors at home, and they should be encouraged and aided to extend their knowledge of the things in nature with which they are likely to come in daily contact throughout their lives. The teacher should go with the children on short walks around the schoolyard and along the roads during occasional noon intermissions, or on longer trips in the fields and woods on Saturdays. It would be well if only a few children were taken at a time; ten or fifteen are all that one teacher can manage on such occasions. Each trip should be taken with some leading object in view, such, for example, as a search for cocoons, or for grasshoppers, or for weed seeds; but this leading object should not shut the eyes of the children to other things. Let them see and hear and feel and smell; let them grow in strength as well as in knowledge. Tell them very little; they should do the telling. Better wait days and weeks for an answer from the children than tell them now and rob them of the pleasure of discovery, provided the subject is within their comprehension.

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[a] Ed. Rev., 27 (1904), No. 5, p. 478.

Nature study at first should consist mainly of observations. The perceptive faculties should be stimulated and developed. For this reason the exercises should never be continued so long as to become wearisome to the children. At first there will seem to be but little connection between the different observations made by the children, but the teacher should never lose sight of the fact that very real and definite relationships exist between the different plants and animals of a given locality and between these things and their inorganic environment. Gradually, therefore, these relationships should be brought out. The children should describe and draw the objects seen. This will lead to comparison and judgment. Suppose, for example, that the children examine two trees of the same species, one growing in open ground, with an abundance of plant food and plenty of room for development; the other growing in a dense forest, with little room for either root or branch; one with short, stocky trunk and dense, symmetrical top; the other with tall, slender trunk and small, irregular top. By comparing certain well-known features of bark and leaves the children will readily recognize the two trees as belonging to the same species, but it will require considerable exercise of the reasoning faculties and pretty good judgment for them to get at the causes which have brought about the marked differences between them. Such opportunities to reason and judge are frequently offered in nature study, and the teacher should improve every opportunity to place them before her pupils.

After the first year or two, the time depending on the progress the children have made, more attention should be given to studying life histories of plants and animals (especially birds and insects), so that these may be recognized in all stages of their development and their economic relations determined. This will enable the pupils to decide whether a given species is mainly beneficial or harmful, and will set them to thinking about means of perpetuating or exterminating the species. This last consideration is the one which mainly determines the attitude of the farmer toward his field crops, domestic animals, and fowls, as well as toward the weeds and other pests that annoy him. When the nature-study teacher and her pupils have arrived at this point of view they will be in a position to pass over as unimportant such details as color of hair, length and number of teeth, number of leaves, length of petioles and internodes, and a hundred other peculiarities of plants and animals, except as these peculiarities have a direct bearing upon the perpetuation of the species or upon their usefulness or harmfulness to man. Such a point of view and such an attitude toward the things studied will aid greatly in developing in the children the faculty of critical discernment. This faculty, according to President Eliot, of Harvard, "ought to be carefully and incessantly cultivated by school, college, and the experience of life, for it is capable of contributing greatly to happiness as well as to material success."

Such critical studies of plants, animals, soils, weather conditions, and other natural objects and phenomena, in their relation to each other and to man, will give the pupils an excellent preparation to take up at the beginning of their sixth or seventh year in school the more formal study of the elements of agriculture.

## ELEMENTARY AGRICULTURE.

The course in elementary agriculture may be given most appropriately during the last two years in the rural common school. The time to be devoted to this course will necessarily vary in different schools, but it is believed that on the average not less than one hour per week during two years will be required to make the course effective. A well-arranged and up-to-date text-book, with illustrations and suggestions for practical exercises, should be adopted as a basis for this study. A few such books already exist, and an increased demand would undoubtedly lead to the production of others and the still further improvement of books of this class. The text-book will in most cases be necessary as a more or less definite guide for the teacher, who will in all probability be without special training in agriculture. It will also be helpful to the pupils in giving a systematic view and in fixing definite knowledge of the subject, and to the parents in showing them what such instruction really involves and in creating an interest in the subject-matter of the books.

The instruction in the class room should be supplemented by simple experiments with soils, plants, and animals, both at school and at home. Every effort should be made to connect the instruction with the home life of the pupils. As an aid to the accomplishment of this aim the pupils should be taken on occasional Saturday excursions to neighboring farms to see improved live stock, examine plans of buildings, and take notes on methods of cropping and cultivating. Visits to county fairs, where arrangements could be made to allow the older pupils to judge some of the live stock, fruits, and grain, and compare their scores with the work of the judges, would be fine training for the classes in agriculture. This scheme has been tried with older students of agriculture and has met with thorough approval. The officers of the fairs could probably be induced to offer prizes for products grown by the pupils and for other agricultural work done by them, or special exhibits of their work could be made at farmers' institutes or other meetings attended by their parents. All these things would tend to create an interest in farm life, and would encourage parents to make the farm more attractive to the children.

The schoolrooms should be provided with illustrative material consisting of charts, pictures, collections of specimens (largely made by the pupils), and boxes, cans, plates, and other inexpensive material which can be used in making apparatus for conducting experiments. There should also be a school library containing at least a few standard reference books on the different divisions of agriculture and the publications of the State experiment stations and the United States Department of Agriculture.

The text-book of agriculture should give an orderly and progressive treatment of the elements of plant production, animal production, and dairying, together with brief and very elementary discussions of a few topics in rural engineering and rural economics. The following syllabus shows in a general way what such a text-book might include:

## SYLLABUS OF ELEMENTARY COURSE IN AGRICULTURE.[a]

### I. PLANT PRODUCTION.

- (1) THE PLANT
  - Structure
  - Physiology—how plants
    - Feed.
    - Grow.
    - Reproduce by
      - Seeds
        - Trace life history from seed to seed, noting pollination, crosses, hybrids, etc.
      - Bulbs.
      - Cuttings.
      - Grafts.
      - Buds.
- (2) THE ENVIRONMENT OF THE PLANT.
  - Climate
    - Light.
    - Heat.
    - Moisture.
    - Air.
    - Study these in relation to plant growth.
  - Soil
    - Nature and functions.
    - Origin.
    - Properties
      - Distinguish between light and heavy soils, porous and impervious soils, soils that bake and those which do not, etc.
    - Classification
      - Main classes, such as sand, clay, loam, peat, silt.
    - Temperature.
    - Aeration.
    - Moisture.
    - Management.
      - Tillage.
      - Drainage.
      - Irrigation.
      - Enrichment.
        - Farm manures.
        - Commercial fertilizers.
      - Impoverishment.
      - Cropping—rotation.

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[a] In this syllabus the same general arrangement of topics has been made as in the higher courses outlined by this committee, but it is of course to be understood that the treatment of these topics by the teacher in the common school should be brief, simple, and elementary.

- (3) FARM CROPS
  - Classification — Include only the most general classes, suc as cereals, grasses, legumes, tubers, et
  - Individual crops. (Study one or more of the leading crops of the region.)
    - Name.
    - Place in classification.
    - Varieties.
    - Culture
      - Preparation of soil.
      - Selection of seed.
      - Testing of seed.
      - Planting.
      - Cultivating.
      - Protection from pests.
        - Weeds.
        - Diseases.
        - Insects.
        - Birds.
        - Mammals.
      - Harvesting.
      - Marketing.
- (4) FRUITS — One or more of the leading fruits of the region shoul be studied in the same manner as farm crops.

## II. ANIMAL PRODUCTION.

- (1) DOMESTIC ANIMALS—THEIR TYPES AND BREEDS.
  - Horses
    - Draft.
    - Trotting.
    - Roadsters, etc.
  - Cattle
    - Dairy.
    - Beef.
  - Sheep
    - Wool.
    - Mutton.
  - Swine.
  - Poultry.
  - Bees.
  - Bring out leading characteristics of one or tw leading breeds of eacl type represented in given region.
- (2) CARE AND MANAGEMENT OF DOMESTIC ANIMALS.
  - Feeding — Only the most general statement regarding the food requirements of different animals anc for different purposes, and exercises in compounding ration suitable to a given region.
  - Hygiene
    - Water supply.
    - Exercise.
    - Shade.
    - Condition of inclosures as to—
      - Comfort.
      - Ventilation.
      - Cleanliness.
  - Preparation and care of product.
  - Marketing product.

## III. DAIRYING.

- (1) THE DAIRY COW
  - Type — A more detailed study of the dairy type tha was given under animal production.
  - Feeding, care, and management.

- (2) MILK
  - Composition
    - How determined.
    - Relation to price.
  - Handling
    - Cleanliness
      - Stables.
      - Cows.
      - Attendants.
      - Vessels.
    - Straining.
    - Aerating.
    - Cooling.
    - Relation to souring or tainting of milk.
  - Uses
    - For consumption as milk or cream
      - Putting up in cans or bottles.
      - Marketing.
    - For condensing
      - Putting in cans and hauling.
    - For cheese making.
    - For butter making.
      - Creaming
        - By setting in pans.
        - By use of separator.
      - Churning
        - Temperature.
        - Kinds of churns.
      - Salting.
      - Coloring.
      - Working.
      - Packing.
      - Marketing.

## IV. RURAL ENGINEERING.

It is not thought that the pupils in a rural common school will be prepared to study the problems involved in rural engineering from the view point of the engineer, but it is hoped that there will be some opportunity to examine the plans and structure of good types of buildings, fences, roads, etc., and to devote some time to drawing simple plans of farms, buildings, and other works. The importance of good roads, hygienic water supply and sewage disposal, and of caring for farm machinery should be emphasized.

- (1) FARM PLANS
  - Size and location of fields.
  - Location of buildings, fences, drains, and roads.
- (2) CONSTRUCTION OF BUILDINGS AND WORKS.
  - Buildings
    - House.
    - Barn.
    - Outbuildings.
    - Fences.
  - Water system.
  - Sewage system.
  - Roads.
  - Irrigating system
    - Only in regions where irrigation is practiced.
- (3) FARM MACHINERY
  - Interesting facts regarding the development of farm machinery in a way to encourage the more general use of improved machinery.
  - The importance of caring for and repairing farm machinery.

### V. RURAL ECONOMICS.

Most of the topics under rural economics are too broad to be included in a brief course in agriculture, or too complex for the comprehension of common school pupils. It is thought, however, that some of the general principles of marketing and farm accounts might be taught in this connection. The main factors in marketing will probably be best considered in connection with the disposal of particular products, as indicated above under plant production, animal production, and dairying. The following topics are appropriate for this course:

(1) MARKETING
- Preparation for market.
- Choice of market.
- Transportation.
- Method and cost of sale.

(2) FARM ACCOUNTS
- Feed and milk records.
- Crop records.
- Breeding records.
- Inventories.
- Bookkeeping.

This to include only the most general suggestions and a discussion of the importance of keeping full and accurate records.

# ANNUAL REPORT OF FARMERS' INSTITUTES, 1904.

By John Hamilton,
*Farmers' Institute Specialist, Office of Experiment Stations.*

The duties of the farmers' institute specialist during the year have been those of organizing the work of the office, of securing information as to the condition of the institute work in the United States and in foreign countries, and of rendering assistance to the several State directors and institute lecturers through correspondence, personal visits, and the sending out of agricultural literature.

A complete list of institute lecturers in the employ of the State directors was secured and published as Circular No. 51 of this Office, and later a revised edition of this circular corrected to June 1, 1904, was prepared and issued. Copies of this publication were sent to all of the directors of the agricultural experiment stations of the country with the request that they select from it and add to their mailing lists the names of such persons as are not already receiving their publications. This request was quite generally complied with and numerous expressions of appreciation have come from the lecturers to whom the bulletins have been sent. A similar request was made to the Division of Publications of this Department with equally satisfactory results.

Copies of the laws enacted by the several States, including those of the Province of Ontario, Canada, relating to farmers' institutes were collected and published as Bulletin No. 135 of this Office. Full statistical reports were sent in by the directors of institutes giving the condition of the work in the several States and Territories. These reports were collated and presented in a report by the institute specialist to the Director of the Office of Experiment Stations and printed in the annual report of the Office for 1903.

Acting upon a suggestion made by Mr. W. L. Amoss, director of farmers' institutes of Maryland, a room was secured and fitted up in the Agricultural Building at the St. Louis Exposition for use as a headquarters for farmers' institute workers. Through the courtesy of the chief in charge of the agricultural exhibit, room N, in the gallery of that building, was assigned for this purpose, and a custodian provided by the exposition authorities was placed in charge. A card register was provided for the enrollment of institute visitors, and a question box with suitable cards upon which to write the queries was placed in the room for the use of any who may desire information respecting the institute work or that of the National Department of Agriculture. The cards are intended to be taken from the box from time to time and forwarded to the office in Washington for reply.

Arrangements have been completed with a number of scientific experts for the preparation of sets of photographs of 40 or 50 to each set from which to prepare lantern slides illustrative of important agricultural subjects. Each set of photographs is to be accompanied by a syllabus containing explanations of each slide and provided with full references to the literature of the subject. The author of each illustrated lecture has been requested to add an appendix to his syllabus in which there will be given such statistical data relating to the subject as may be useful, the purpose being to distribute the syllabi among members of the audience who may be specially interested, to be kept for future reference.

Correspondence has been opened with the representatives of foreign nations for the purpose of securing information respecting the methods in use in the older countries for the development of their agriculture. Data have also been received from the principal steam railway systems of the United States and Canada showing the extent to which they have cooperated in the farmers' institute work and in advancing the interests of agricultural people in the sections through which they run.

The institute specialist has visited during the year 23 States and 1 Territory for the purpose of attending conventions of agricultural representatives and has delivered before these conventions 29 addresses. He has been unable to attend all of the meetings for which invitations have been received, owing to conflicting dates and to the necessity for giving attention to correspondence and to the other duties of the office.

The year has been largely devoted to becoming acquainted with the conditions that exist in institute affairs throughout the country and to the study of these conditions, with a view to the solution of some of the problems that confront institute workers in the several States.

## NATIONAL MEETING OF INSTITUTE WORKERS.

The annual meeting of the American Association of Farmers' Institute Workers, which usually occurs in the early part of the season, was deferred this year until the autumn. The meeting was held at St. Louis, October 18–20. One hundred persons registered as delegates, representing 24 States and 1 Territory, together with the District of Columbia and three Provinces of Canada. The proceedings were stenographically reported and will be printed as a bulletin of this Department.

The programme confined the speakers chiefly to the discussion of methods in institute work, to the purposes of the institute, and to its relation to other educational institutions.

The impressions left by the meeting, in comparing it with those of several years ago, are a realization of the great progress that has been made in institute efficiency in all of the States, and of assurance that much of this progress is due to the personal acquaintance and exchange of views among institute workers, made possible by the organization of the American Farmers' Institute Association. In discussing the future the conviction was general that the educational feature of the work should be magnified, that more should be done by the institute for the boys and girls out upon the farms, and for the development of the woman's institute idea.

A striking demonstration of what the institutes have accomplished was furnished in a statement respecting the work in Ontario, Canada, where the entire agriculture of the province has been revolutionized within a few years through institute instrumentality. A prominent representative of the province declared that the institute was the potent influence that had put life into Canadian agriculture, and as evidence of this the production and value of beef, bacon, and cheese had been raised in the past eight years in the Province of Ontario from $31,000,000 to $65,500,000, mainly through the information imparted at the farmers' institutes, which last year held 833 meetings, reaching 110,000 men and 10,000 women.

The following officers were elected for the ensuing year: President, J. C. Hardy, of Agricultural College, Miss.; vice-president, E. A. Burnett, of Lincoln, Nebr.; secretary-treasurer, G. C. Creelman, of Guelph, Ontario; executive committee, the president and the secretary-treasurer, ex officio; J. G. Lee, of Baton Rouge, La.; F. H. Hall, of Aurora, Ill.; L. A. Clinton, of Storrs, Conn.

## PROGRESS OF THE INSTITUTES.

The progress of the farmers' institute work throughout the country during the past year was fully equal to that of the year which ended June 30, 1903. The reports of the State directors show that, while there has been an apparent falling off in the attendance, there has nevertheless been an increase in the number of institutes held, the amount of money appropriated, and in the number of teachers upon the State lecture force. The decrease in the number of persons reported in attendance may be accounted for partly by the unusual severity of the past winter and partly by the general adoption by the State directors of the new method of estimating attendance recommended by the American Association of Farmers' Institute Workers.

Institutes were held in 46 States and Territories, with a total reported attendance of 841,698, as against 904,654 in 1903. The number of institutes was 3,306, an increase of 127 over the previous year. The total number of sessions, which is the proper unit of estimation, was 10,622. This is 1,062 more than were reported for 1903. Comparison of the aggregates in the reports of the two years does not show the true situation, from the fact that in 1903 some States reported the number of sessions that made no report in 1904, and likewise in 1904 States reported that had not sent in any report in 1903. A comparison of the data furnished by the States reporting for both years shows that in 1903 these States held 9,316 sessions of institutes, and that in 1904 they held 9,235 sessions, a loss in 1904 in the States compared of 81 sessions.

There seems to be a disposition to increase the number of one-day institutes and to correspondingly decrease the number of two-day meetings. The reports show that 1,755 one-day meetings were held during the year, 1,476 two-day, and 75 three-day meetings. Comparing these figures with those reported for the previous year there is shown a reduction of 165 in the number of two-day institutes and a gain of 396 in the one-day meetings.

The appropriations for institute purposes amounted last year to $210,611.03, of which $203,066.56 was expended. The State governments appropriated from their treasuries $201,216.12 for institute purposes, and the agricultural colleges and agricultural experiment stations, together with private individuals, contributed $11,394.91. The appropriations for the coming year, so far as reported, amount to $223,164. If the States not reporting contribute the same amount as they gave last year the sum available for institute purposes for the coming season will aggregate $230,489.71.

The amount actually available for institute work is considerably larger than these figures show, for the salaries of the directors in 26 States are not included, neither do they embrace, except in a few States, the cost of printing the 329,200 reports of institute proceedings, which was the number published and distributed last year. A conservative estimate of the amount that will be available for institute purposes next year, embracing with the money appropriated the two items just referred to, will reach in all probability $340,000.

There is also a growing appreciation of the value of the instruction that is being given by the institute lecturers, and a firmer belief in the practicability of the methods that the institutes have adopted for conveying information to farmers. This is evidenced by the demands that come to the State directors for a much larger number of meetings than they are able to supply. The effort to meet this demand no doubt accounts for the increased number of one-day institutes reported for the past year.

The expansion of the work, so far as increasing the number of days of institutes is concerned, will be very little, if any, greater than as additional funds are provided for institute support. The reports for the year ended June 30, 1904, show that the institutes are costing an average of about $42 per day. This sum provides for the salaries and traveling expenses of the lecturers; the heating, lighting, janitor services, and rent of halls; the cost of printing, advertising, and postage, together with such other minor incidental expenses as are connected with the holding of institute meetings. This average is probably as low as will be possible, for in arriving at it States are included in which the lecture service is gratuitous so far as the salaries of the lecturers are concerned, and in which also the local committees provide for the hall rent and meet all other local expenses.

In making up the blank form for sending out to State directors for information respecting their work a number of questions were asked relating more particularly to the "methods" pursued in the different States in conducting the institutes. To some of the queries almost all of the directors replied, while to others comparatively few gave any information. The replies are of interest as showing what is being done and how many States are pursuing the same or similar methods.

The responses show that there have been no changes in the State laws in any of the States during the year. Nine hundred and fifty-three lecturers were reported as being on the State institute force. Of this number 361 are members of the faculties of the agricultural colleges or of the agricultural experiment station staffs, who contributed during the year 2,131 days of their time to giving institute instruction.

In order to ascertain the extent to which "local lecturers" are being employed in the institutes the following query was sent out: "How many local speakers addressed your institutes?" Forty replies were received. Five directors stated that none had been employed, 7 were unable to give the number, and 28 States reported an aggregate of 3,331 local lecturers, being an average of 119 to each State. Of the 28 States using local instructors 5 had in their employ 2,551, leaving 780 lecturers for the other 23 States.

There were 41 replies to the query, "What compensation do you allow your State lecturers?" Thirteen States replied that the lecturers are supplied by the agricultural colleges and experiment stations with no compensation except that which they receive from the colleges and stations for salaries as teachers in college or station work. Four States pay expenses only; one allows a compensation of from $2 to $4 per day and expenses; two pay $4 and expenses; six pay

$3 to $5 per day and expenses; one, $3 to $8 per day and expenses; six, $5 and expenses; one, $5 to $8 and expenses; one, $10 and expenses; one, $20 per week and expenses; one, $15 to $25 per week and expenses; one, $10 to $50 per week and expenses; one, $25 to $35 and expenses; one, $25 to $50 and expenses, and one $200 per month.

To the question "How many lecturers do you supply to each institute?" 34 replied. One, that he furnished 1 lecturer; eight, 2 lecturers; five, 3 lecturers; one, 4 lecturers; one, 5 lecturers; five, 2 to 3 lecturers; one, 1 to 4 lecturers; two, 2 to 4 lecturers; two, 3 to 4 lecturers; one, 1 to 5 lecturers; one, 2 to 5 lecturers; two, 3 to 5 lecturers; one, 4 to 5 lecturers; one, 1 to 6 lecturers; one, 2 to 6 lecturers; one, 3 to 6 lecturers.

To the question "What proportion of the time of the institute is given to the State lecturers?" 29 replies were received. Nine gave all the time to the State lecturers; 5, one-half of the time; 1, one-third of the time; 3, two-thirds of the time, and 11 gave three-fourths of the time.

In reply to the question "Was any special topic assigned to be discussed in each institute last season?" 12 replied that such topics had been assigned and were discussed.

In reply to the question "Do you hold women's institutes?" 11 replied "yes" and 31 "no."

To the query "Do you have exhibits of agricultural implements and products at your institutes?" 9 replied that they have such exhibits, 20 that they have them occasionally, and 13 not at all.

Four States held institutes for boys, one holding 2 meetings, one holding 30 meetings, and one holding 72 meetings. One State director reports that he has his institute lecturers visit the public schools in the locality where an institute is held and deliver addresses to the children on agricultural topics.

To the question "Do you have county institute organizations?" 44 replies were received. Seventeen answered "yes," 21 "no," and 5, "a few." One reported that his State had formed senatorial district instead of county organizations.

Thirteen directors who replied to the question, "What is the best form of local or county institute organization?" agreed that some form of local organization was necessary—either farm clubs, county committees, or incorporated county institutes.

Out of the 46 States and Territories reporting "sources of income" for institute purposes it appears that the institutes in 28 States are provided for by appropriations made by the State governments, 10 are sustained by local subscriptions or from agricultural college and experiment station funds, and 8 receive appropriations from both the State and the agricultural college and experiment station. An examination of the reports from all of the States and Territories shows that the 3,306 institutes held last year cost $61.42 per institute, and that the 10,622 sessions cost an average of $18.91 per session. There were 4,843 days of institutes in all. The reports which are comparable show that the institutes cost $41.93 per day. Twenty-nine States and Territories report 329,200 copies of their institute proceedings as having been published and distributed during the year.

Forty-four directors replied to the question "By whom are the dates, places, and programmes of your institutes arranged?" In 24 States the State directors complete all of the arrangements and in 10 the work is by joint conference between the State directors and the local committees. In 4 States the arrangements are by the local officers, and in 6 by committees of the agricultural colleges and experiment stations or by special institute boards.

To the question "Do you hold a round-up institute?" 16 reported that they do, 26 that they do not. Fourteen of the 16 reporting gave the number of sessions at the round-up institutes as 102, and 13 that reported attendance gave it at 12,298.

Twenty-two States reporting upon "New features of their work introduced during the year" make the following replies: Have introduced shorter talks; more discussion; the practical advantages of centralized schools; discussion of industries of importance to each locality; organized institutes in circuits; have provided for road lectures and road demonstration work; open air or basket institutes; special children's sessions; normal institute meetings for the instruction of lecturers; corn contests for boys under 18; forest management; correspondence and reading courses; have united all agricultural societies of the State in institute work; introduced lady speakers; sent out demonstration car or traveling institute; organized a woman's department of farmers' institutes; introduced demonstrations in cooking and food preparation; taken up industrial work for girls through the medium of women's clubs; have institute lecturers visit the public schools and give addresses upon agricultural topics.

## NEEDS OF THE INSTITUTES.

As a result of personal observation and of information received from other sources, there seem to be at least three directions in which improvement of the institutes is greatly needed. There is need (1) for better organization of the work in the several States, (2) for more money for institute purposes, and (3) for an increased number of efficient workers. There are also minor embarrassments that retard the work, due to local conditions peculiar to each State, but in most instances these would be readily overcome if the three great needs referred to were adequately met.

If the farmers' institutes of any State are to become efficient features of its educational system, the first quality that they must possess is that of permanency. They ought to be so organized as not to be dependent for their existence or efficiency upon the capability or life of a single individual. The organization and government should be upon lines similar to the organization and government of other public institutions that have lived and prospered notwithstanding the vicissitudes of time and the loss of leaders. It must be an organization with its purposes recorded and the means for the accomplishment of these purposes clearly and definitely known, not in a general way and by one man only, but in detail and by many.

The form most approved is that of a strong, local, permanent organization in every institute district, with fully and clearly defined duties and powers, the whole system to be subject to the oversight and limited control of a central State authority whose duties and powers are prescribed by law.

An examination of the laws controlling institutes in the several States, and of the practice in States in which no legislation has yet been had, shows how far short most have come of this ideal. This condition is explained and excused by the fact that, so long as the institutes were in their formative and experimental stage and their value not generally known, it was important and unavoidable that a variety of methods should be tried in order to discover whether they had any right to exist. But now that their usefulness is conceded and their perpetuity and development are desired, the question of form of organization best adapted for carrying out their purposes becomes of great importance and ought to be seriously considered by those having the institutes in charge.

The second great general need of the institute movement is more money with which to carry on the work.

Reference has already been made to the expansion of this movement, and to the fact that this is limited by the money at the disposal of the directors. The need, however, for additional money is felt in some of the States much more than in others. In eight States and Territories no appropriation is made by the legislatures for institute purposes, and the work is dependent for support upon the amount contributed by the agricultural colleges or experiment stations, supplemented by individual subscriptions. In nine other States and Territories the appropriations by the legislatures were $1,000 or less, and in eight other States the appropriations by the legislatures were from $1,200 to $2,000 per year. The twenty-five States and

Territories just referred to have a total population of 25,000,000, of whom 10,000,000 are engaged in agriculture. These States appropriated last year altogether only $20,344 for farmers' institutes, which is less than two mills to each rural inhabitant per year, while a single other State, with an agricultural population of only a little more than 1,000,000 (1,077,661), appropriated $21,500 for the same period. It is manifest that before the institutes in these twenty-five States can be extended or greatly improved their legislatures will have to grant them increased support.

One of the first duties of the institute workers, therefore, in these States, as well as in others in which inadequate appropriations are made for institute support, is to see that the subject is brought to the attention of the lawmaking bodies in such a way as to secure a proper recognition for this work.

The third important general need of the institutes is an adequate supply of competent lecturers. Most of the teachers ought to be acquainted with the science as well as with the practice of agriculture. The agricultural colleges can not, under present conditions, meet the demand for trained institute lecturers, and special means must therefore be employed to discover other men and women and give them the training and information which they need to equip them for lecture work.

## NORMAL SCHOOLS FOR INSTITUTE WORKERS.

Each year makes more apparent the need of some system for instructing the institute workers. Agricultural science is advancing so rapidly that unless those who are to give instruction in agriculture at the institutes devote a considerable part of their time to study and reading they will soon become unfit for their work as instructors. The men whose professional duties require them to keep abreast of scientific research, such as the members of the agricultural faculties in the land-grant colleges and those who are on the agricultural experiment station staffs, are specially well situated in this respect and have less need for meeting as normal scholars in agricultural study; but the lecturer out of college and not identified with the experiment station work is liable to fall behind in his knowledge of the new discoveries that are continually being made, and unless he has some proper opportunity for becoming informed will soon cease to be a competent or safe teacher.

Thus far the State directors of institutes have depended upon the agricultural colleges and experiment stations for their supply of scientific teachers, and upon practical farmers for the discussion of methods in farm management. The work, however, has expanded so rapidly as to make it impossible for the colleges to supply the num of men required, and accordingly some of the States are making effort to increase the efficiency of their lay institute workers by bri ing them together as a normal class for purposes of instruction, sessions continuing from one to two weeks. Such a class of instit workers was held last year in New York—one week at the Gen Agricultural Experiment Station and one at the Cornell Universi Other States are planning for the establishing of similar classes.

The fact is now recognized that bulletins or printed docume sent out to the lecturers, although they are helpful, can not take t place of systematic instruction given through oral teaching. It possible by means of capable teachers to treat of methods and p sent what is known upon a particular subject in a way much m effective than can be accomplished by the use of the printed pa The living teacher has opportunity to accompany the facts that presents with illustrations and explanations that fix them in t minds of his hearers and enable them to more clearly comprehend t truths taught, so that they in turn will be better able to impart th to others.

Precisely how this normal instruction ought to be given and wh form of organization will best serve the purpose are not yet cle Experiments made thus far bring out several practical difficulties the way of organizing normal schools for institute instruction any single State.

The first is that the institute lecture force in most of the States comparatively small. Because of this and by reason of the limit number of instructors available at any one institution, it is alm impossible to so divide the lecture force into classes of sufficient nu ber that the instruction given may be suited to the peculiar needs the several lecturers in the line of their specialties. Unless this c be done each student is obliged to attend all of the lectures, wheth or not the subject is one upon which he desires information, and th during the entire course he may have but one or two lectures on h specialty.

The second difficulty is that the agricultural colleges and expe ment stations are not as yet sufficiently equipped in their teachi force of experts to do more than cover a quite limited range of topi Some institutions make a specialty of a single phase of agricultu as animal husbandry, forestry, irrigation, plant breeding, soil physi or other branch of agriculture, and are not prepared to give instru tion in the particular subjects which the institute lecturer desires teach.

The third difficulty is that no one institution can afford to give t use of its teaching force for the length of time needed to make a cour effective. A four or six weeks' term is an impossibility for any ag cultural college or experiment station, and yet this is not too long for a class of institute lecturers to devote to the study of their several specialties. One week is about as much as any institution can contribute annually outside of its regular work, and this is too short a period for the proper treatment of the subjects that need to be considered.

For the present, and until the colleges have been greatly strengthened and until the institute force has been greatly enlarged, it would seem to be necessary for several States to unite in a normal school to be held at different institutions each year, to be equipped with a teaching force contributed by each. This would overcome the difficulties mentioned and make it possible to classify the students and thus enable them to devote their time to subjects that more nearly relate to their several specialties. No one institution would be seriously embarrassed by the loss of the number of its teaching force which it would be called upon to furnish. The additional number of subjects that could be offered in such a school would give character to the meeting and beget enthusiasm in teachers and scholars that would do much to popularize it and give it standing among educational institutions.

An essential feature of a school that is to train institute lecturers is that it shall be in contact with field demonstrations or experiments in agriculture that are being conducted along scientific lines. By changing the location of the normal school each year to a different institution the students would have the advantage of contact with a wide range of experiment work and thus be far better equipped for giving instruction than would be possible if they had only visited a single institution. The expenses of the students would be but slightly increased over that required to attend a State school, and the acquaintance with fellow-workers and college experts thus formed would be much more extended and be of lasting benefit. States might be grouped whose agricultural interests are most similar, as, for instance, New York, New Jersey, Pennsylvania, Delaware, Maryland, and Ohio. These six States represent an aggregate institute force of 226 lecturers. Thirty-three of these lecturers are connected with the experiment stations of their several States or with the faculties of their agricultural colleges, leaving 193 who would be likely to be in attendance at a school formed by the union of the six States designated.

It is reasonable to expect that others also, knowing of the normal school of instruction provided and of its high character, would be attracted in perhaps considerable numbers and thus add to the classes that would annually assemble.

Suitable courses of study for such a school could be prepared by the deans of the agricultural faculties of the several colleges and by the directors of the experiment stations of the States interested, assisted by the State directors of institutes for these States. These representatives could also select the teaching force or faculty of the normal school each year and make requests to the respective institutions for the assignment of the persons selected, each institution to be expected to meet at least partially the expenses of its representatives and instructors. A moderate matriculation fee could be charged to students; that would provide a fund for such incidental expenses as it might be found necessary to incur. The courses of study should be constructed to require at least two terms for completion, and a certificate might be given to those who satisfactorily complete any one or more of the courses offered. A portion of each day during the course ought to be devoted to practicum work. The inauguration of such a movement could quite appropriately be committed to the Association of Colleges and Experiment Stations, and the plan be submitted to the American Association of Farmers' Institute Workers for approval.

## DEPARTMENT AID TO INSTITUTES.

The National Government, by establishing the office of farmers' institute specialist in the Department of Agriculture, has recognized the fact that the States have need of assistance in their institute work, and that the Government is under obligation to furnish at least some aid in this direction. How far it should go in supplying assistance, and the exact form which the assistance should assume, have not yet been determined.

As has been stated, this Department has collected information respecting the institute system as it is conducted in the various States and Territories; has secured and had printed the names and addresses of the State directors of institutes and of the institute lecturers; has compiled and published the laws governing institutes in the States and Territories; has visited, through its institute specialist, a large number of the States in order that personal inspection of their systems might be made; has opened correspondence with agricultural experts in foreign countries with a view of becoming acquainted with their systems; has collected data showing the condition of the institutes throughout the United States and Canada; has had experts at work in the preparation of illustrative material for the use of the lecturers, and has made an effort to secure additional appropriation from Congress for the extension of the institute work; has sent out publications to institute teachers, and has also interested in this the experiment stations of the country; has prepared and published reports on the institute work; in short, has discovered the situation in institute affairs, and from the information that has been secured is now ready to act understandingly in an effort to be of wider service.

The Department has discovered that the paramount needs are for better organization of the work in the several States; for more money for institute support, or what is the equivalent, for more institutes, and that there should be some way discovered for increasing the lecture force by providing for the discovery and educating of capable men and women to take up this work.

What can the Department now do other than that which it has already accomplished? It can continue to collect statistics year after year. It can continue to send out its publications to institute lecturers, and to urge the experiment stations to join in this service. It can correspond with institute people and give advice in institute affairs. The specialist can continue to attend a limited number of meetings of farmers and deliver addresses. The Department can continue to keep advised with regard to work similar to ours as conducted by foreign countries. It can follow this routine for years to come and be of service to the agriculture of the country, and it can do this with its present force of an institute specialist and a stenographer.

Important as this work is, it has not been regarded as being the end, but rather as preparing the way for undertaking the much larger and more important work that lies ahead.

Last year, in reply to the query as to what the Department can do to assist in making the State institute work more effective, 16 directors out of a total of 23 replied, asking for a supply of competent teachers. If the judgment of these directors, each of whom has made careful study of the institute question, is correct, then we have a sphere of work opened up that as yet has been practically untouched by this Department and in which there is room for the utmost that the Department can do for all time to come.

A corps of field men in institute work is now a necessity if the Department is to take its proper place in the school of agricultural instruction which the institute represents. The establishing of such a corps of agricultural workers, whose entire time could be devoted to institute work, would not only meet the demands of the States for assistance, but would also bring the Department in a personal and helpful way into direct contact with agricultural people all over the country and increase its value to farming people many-fold.

This Department has a large number of agricultural experts in its employ. A letter recently sent out to the chiefs of the several bureaus and divisions of the Department, calling attention to the need for assistance in the institute field, and requesting the names and addresses of those who could at times be spared for this work revealed the fact that almost all are so occupied with their regular duties as to be practically unavailable for institute service. It is clear, therefore, that if assistance of the kind desired by the State directors is to be furnished and at times when needed, men will h to be secured who will be free from other duties and who can be s out whenever and wherever their services may be required.

There is special reason for the organization of such a body of n in the fact that it is clear there is needed a more effective means the dissemination of the agricultural information which the Depa ment is securing.

Agricultural literature is being issued annually by the Departm by millions of copies, notwithstanding which millions of farmers uninformed and are never reached. Since 1888 this Department had prepared 5,771 separate publications relating to agricultu most of them of great value to farmers. Of these there were prin and distributed during that period 82,735,580 copies. Tests made farmers' institute meetings reveal the fact that very many farm do not read these publications in such a way as to be able to av themselves of the information which they contain, or even to beco aware of the scope of the work which the Department has undertak for the benefit of agriculture or of the great value of the discover which it has made. The great need now is not for more literat so much as for men to take the information that exists and disse nate it among farmers—for the living teacher.

A well-equipped lecture force would call attention to what is bei done in the interests of agriculture throughout the world, and p ticularly would keep farmers informed as to the latest and m practical truths which this Department and the agricultural expe ment stations are demonstrating to be of value. They could lect before farmers' institutes, granges, farm clubs, agricultural societi farm associations, and kindred organizations, and in the interv between the meetings go out upon the farms and into the creame and factories and demonstrate in a practical way that which th teach in the institute meetings or lecture halls. The fact that alm every European country employs a force of men who give instructi in agriculture in their public schools and lecture before societies farmers upon agricultural topics is ample proof, if any were need of the value, importance, and practicability of this kind of work.

## THE STATE REPORTS.

In endeavoring to show the condition of the institute work in t several States it has seemed best to adhere to the method of reporti each State or Territory separately, giving somewhat in detail t character of its institute organization, the work done during t year, and calling attention to such special features as seem to disti guish its institutes from those in other States.

The reports are worthy of careful study and comparison by ins tute workers. They show how diverse are the methods pursued a how the cost of conducting the institutes in different States varies between wide extremes. There is unquestionably need for the serious consideration and discussion of the institute problem, that there may be a general agreement as to what its organization and equipment should be in order to most economically and efficiently fulfill its mission.

## FARMERS' INSTITUTES IN THE SEVERAL STATES AND TERRITORIES.

### ALABAMA.

Population, 1,828,697. Total number of homes, 374,765. Number of farm homes, 217,461. Per cent of farm homes, 58. Approximate population in farm homes, 1,060,644.

Director of institutes.—C. A. Cary, Veterinarian Alabama Polytechnic Institute and Agricultural Experiment Station, Auburn.

The farmers' institute work in Alabama is under the direction of the board of trustees of the Alabama Polytechnic Institute and of the agricultural experiment station. There is no State law regulating or controlling the work. Last year there was appropriated by the college $600 for institute expenses. Twenty-four institutes were held, consisting of 49 sessions, with a total attendance of 3,639. Nine lecturers were employed by the State director for institute service.

The director of institutes is appointed for the period of one year by the board of trustees of the Polytechnic Institute and the agricultural experiment station. Seven members of the college and station staffs participated in the institute work. There are no permanent local institute organizations. The director arranges the programmes, attends to the advertising, and fixes the dates and places for the institutes. The sum of $600 has been appropriated for institute work for the season ending June 30, 1905.

No report of institute proceedings is printed. A six to ten day round-up or convention of institute workers is held annually at the college. At the convention last year there were 130 persons in attendance. Forty-two lectures were delivered, accompanied by 10 demonstrations, lasting from two to three hours each. The institute meetings are not limited to any particular season, but are distributed throughout the year.

### ALABAMA INSTITUTES FOR COLORED PEOPLE.

Director of institutes.—G. W. Carver, director Department of Agriculture and Experiment Station, Tuskegee Normal and Industrial Institute, Tuskegee.

Farmers' institutes for colored people have been organized under the direction of the Tuskegee Normal and Industrial Institute. The expenses of the institutes are met by the localities in which they are held. Meetings are advertised by circulars, personal letters, a through the agency of the various pulpits of the surrounding countr The formation of local organizations to meet once each month encouraged. The lecture service is performed chiefly by the membe of the teaching force of the Tuskegee Normal and Industrial Inst tute. One hundred and thirty-nine institute meetings were held la year, with an average attendance of 65.

### ALASKA.

Population, 63,592. Total number of homes, 13,459. Number of farm hom 27. Per cent of farm homes, 0.2. Approximate population of farm homes, 1

Farmers' institutes have not yet been organized in Alaska, but Pro C. C. Georgeson, the special agent in charge of the experiment stati at Sitka, as he visits the various districts takes advantage of t opportunity to give advice as to more advanced methods that mig be employed in improving the agriculture of the several localities.

### ARIZONA.

Population, 122,931. Total number of homes, 29,875. Number of farm home 7,391. Per cent of farm homes, 24.7. Approximate population in farm home 30,362.

Director of institutes.—R. H. Forbes, Director Agricultural Experiment St tion, Tucson.

The legislative assembly of Arizona in 1903 passed an act providin for "the establishment of farmers' institutes and short courses o instruction throughout the Territory." For this purpose the sum o $2,700 was appropriated. The law places the control of the insti tutes in the hands of the board of regents of the university. Th institute work for the past year consisted of three weeks of lecture at Thatcher Academy, Thatcher, Ariz., on subjects relating to soil irrigation, alkali, pruning of fruit trees, plant lice, plant disease dairying, and feeding. The lectures were by 2 members of the sta tion staff, averaging 2 hours a day for 14 days in all. There was a average attendance of about 40 at each meeting.

### ARKANSAS.

Population, 1,311,564. Total number of homes, 265,238. Number of far homes, 176,017. Per cent of farm homes, 66.4. Approximate population in far homes, 870,878.

Arkansas has no farmers' institute legislation. An attempt wa made at the last session of the legislature to secure an appropriatio for institute purposes. The bill, however, failed by a very narrow margin. The effort to secure an appropriation will be renewed at th coming session of the legislature.

## CALIFORNIA.

Population, 1,485,053. Total number of homes, 341,781. Number of farm homes, 71,119. Per cent of farm homes, 20.8. Approximate population in farm homes, 308,891.

Superintendent of institutes.—E. J. Wickson, Professor of Agricultural Practice, University of California, Berkeley.

The institute work in California is under the general direction of the superintendent of farmers' institutes, assisted by two conductors, one having the central and northern portions of the State and the other having charge of the institute work in the southern section.

The legislature of 1903 authorized the board of regents of the University of California to hold farmers' institutes under such rules and regulations as they may deem proper and at such times and places as they may direct. The law directs that the "course of instruction at such institutes shall be so arranged as to present to those in attendance the results of the most recent investigations in theoretical and practical agriculture." The sum of $12,000 was appropriated for institute work for the next two fiscal years.

During the last year institutes were held in 41 out of the 57 counties. Owing to local climatic conditions and corresponding leisure seasons in various parts of the State, institutes are held every month in the year. There were 113 institutes in all, composed of 380 sessions. The total attendance was 43,680. The cost of the institutes for the year was $7,234. The university contributed $1,234 of this amount, and $6,000 was received from the State appropriation. Twelve thousand five hundred copies of the proceedings were printed and distributed to persons on the regular mailing list of the agricultural experiment station. There were 25 lecturers employed by the State director, 10 of whom were members of the agricultural college and experiment station staffs. The college and station contributed 340 days of lecture service. The arranging of dates, places, and the preparation of programmes for institutes are in the hands of the superintendent.

The superintendent provides two lecturers for each one-day institute and three lecturers for each institute continued two days or more. There are no special or permanent local organizations in the several counties, but a local committee appointed by the last institute takes charge, under the general direction of the State superintendent, of the work of preparation for future meetings. Correspondence courses in agricultural science in its various branches have been added to the institute activities, and the superintendent reports that these courses are being well received.

## COLORADO.

Population, 539,700. Total number of homes, 127,459. Number of homes, 24,745. Per cent of farm homes, 19.4. Approximate populatio farm homes, 104,701.

Director of institutes.—A. M. Hawley, Secretary State Board of Agricult Fort Collins.

There are no specific laws in this State in regard to farmers' stitutes. The only law that relates to them is the one in regard to duties of the State board of agriculture where under the "duties secretary" the act directs that "he shall encourage the formation agricultural societies throughout the State." The funds with wh to carry on the work have been contributed by the State agricultu college. The total expenses last year were $517. Fifteen institu were held, made up of 36 sessions, and the total attendance was 1,6 The lecture force was provided from the staffs of the agricultu college and experiment station. Twelve persons were sent out this service, contributing, in the aggregate, 48 days of time. Th has been no arrangement made for the publication of the proceedin

## CONNECTICUT.

Population, 908,420. Total number of homes, 203,424. Number of fa homes, 26,609. Per cent of farm homes, 13.1. Approximate population farm homes, 119,003.

Superintendents of institutes.—James F. Brown, Secretary State Board Argiculture, North Stonington; J. B. Noble, Secretary Connecticut Dairyme Association, Hartford; H. C. C. Miles, Secretary Connecticut Pomological Se ety, Milford.

Connecticut has no special law regulating the holding of farme institutes. The State board of agriculture, the Connecticut Dai men's Association, and the Pomological Society are each carrying institute work in the State. These different organizations recei money from the State for the benefit of agriculture in general; t Dairymen's Association for the dairy interests, the Pomologi Society for the interests of fruit growing. The methods used these different organizations in carrying on their work and dissen nating information are entirely in their own discretion. Each has institute committee appointed to have charge of the institute wo The board of agriculture requires that localities applying for ins tutes shall "furnish a suitable hall, provide local transportation speakers and visitors, music, if desired, and entertain by collation otherwise unless there are convenient hotel accommodations." T board pays for printing, traveling expenses, and services of speake

During the past year there has been cooperation between the thr societies and the institutes were held in common, instead of separat as heretofore. A general round-up or annual meeting of the institute workers is held each year, lasting from two to three days.

Eighteen institutes were held during the year, made up of 36 sessions, and attended by about 2,500 persons. There are 29 lecturers upon the institute force of the State. Twelve of these were furnished by the State agricultural college. The total expense of the institutes for the past year is given at about $200. Reports of the proceedings of the institutes are published. There are no specific local organizations for conducting institutes, but the superintendents depend upon the local granges and farm clubs for cooperation.

## DELAWARE.

Population, 184,735. Total number of homes, 39,446. Number of farm homes, 9,677. Per cent of farm homes, 24.5. Approximate population in farm homes, 45,260.

Director of institutes.—Wesley Webb, Dover.

The legislature of the State of Delaware in 1903 amended the law respecting farmers' institutes, which formerly permitted a separate institute director for each of the three counties, by providing "that the State board of agriculture may appoint a director of farmers' institutes for the State to cooperate with the farmers' institutes of the several counties." The sum of $600 is annually appropriated for institute purposes and is apportioned equally among the three counties. The salary of the superintendent is provided for outside of this amount. The law provides that the failure of any county to hold an institute in any year shall forfeit its appropriation. The objects of the institutes, as declared by the law, shall be "the discussion, orally or by written essays or papers, of agricultural and kindred questions and for the dissemination of agricultural knowledge among the farmers of the State."

Eighteen institutes were held during the past season, made up of 42 sessions and attended by 3,436 persons. Fourteen lecturers were on the State force. Two of these were furnished by the agricultural college and the experiment station, contributing 18 days of time to the institute work. The total expense amounted to $750. The director of institutes is also secretary of the State board of agriculture.

Local institute organizations are provided for by an act of the legislature, which requires that there shall be a president, vice-president, secretary, treasurer, and an executive committee for each county organization, and that these officers shall receive no compensation and are to hold their office for one year. The superintendent states that it is expected that the next legislature will authorize the printing of 5,000 copies of the report of the State board of agriculture, and that this report will include the proceedings of the farmers' institutes.

## FLORIDA.

Population, 528,542. Total number of homes, 117,001. Number of f homes, 40,965. Per cent of farm homes, 35. Approximate population in f homes, 184,989.

Director of institutes.—C. M. Conner, Professor of Agriculture, Universit Florida, Lake City.

Authority to hold farmers' institutes is committed by the Stat the board of trustees of the Florida Agricultural College and agricultural experiment station. The appropriation to these insti tions contains the following clause: "For holding farmers' institu $2,500." The superintendent is appointed by the board of trust of the college and station, to whom, in connection with the presid of the college, has been delegated the power to make rules for holding of institute meetings and to expend the money appropria for institute purposes. Last year 15 institutes were held, consisti of 32 sessions. Sixteen hundred and five persons were in attendan Nineteen instructors are upon the lecture staff, 2 of whom are c nected with the agricultural college. The total cost of the institu was $1,240.

The local organizations consist of a chairman in each county a pointed by the superintendent of institutes, with authority to ma all necessary local arrangements for institute meetings. Three tho sand copies of reports of the proceedings were distributed last ye The superintendent, in addition to his duties as director of farme institutes, is also professor of agriculture in the agricultural colle of Florida. The dates and places for all institutes are arranged the superintendent, and notices of meetings are published from thr to four weeks in advance.

## GEORGIA.

Population, 2,216,331. Total number of homes, 455,557. Number of fa homes, 221,395. Per cent of farm homes, 48.6. Approximate population in fa homes, 1,077,138.

Director of institutes.—H. C. White, President State College of Agricult and Mechanic Arts, Athens; Harvie Jordan, Assistant Director of Institut Monticello.

There is no law in this State providing for the holding of farme institutes. The work has been conducted by the college of agric ture of the State University, and the money needed for carrying the work has been appropriated by the trustees of that universit The general direction of the work is in the hands of the president the agricultural college, aided by a field assistant, Mr. Harvie Jorda of Monticello. One thousand dollars was set aside by the trustees the university for bearing the expenses of institutes for the past yea Thirty-four institutes were held, consisting of 68 sessions, attende by about 7,000 persons. Fourteen lecturers were upon the State force, 8 of whom were representatives of the faculty of the agricultural college and of the station staff. These two institutions contributed thirty-seven days of time.

No institutes had been held in Georgia for several years until in 1903. During the past year an institute has been organized in each senatorial district, having local officers in each county embraced in the district. Each locality is expected to secure a suitable hall for meeting without charge to the State superintendent, and to provide all of the local accommodations needed for successfully conducting the meeting. The State supplies from two to three lecturers to each institute whose expenses are paid out of the agricultural college funds. The dates, places, and programmes for the institutes have thus far been arranged by the director, and the meetings are advertised at least two weeks in advance by means of the county press. Two thousand copies of reports of the institutes were printed and distributed during the year. A round-up meeting of institute workers, consisting of three sessions, was held, having an attendance of 200 persons.

## HAWAII.

Population, 154,001. Total number of homes, 36,922. Number of farm homes, 1,409. Per cent of farm homes, 3.8. Approximate population in farm homes, 5,852.

President of institutes.—Jared G. Smith, Special Agent in Charge of the Agricultural Experiment Station, Honolulu.

There are no laws in force in this Territory relating to farmers' institutes. A farmers' institute society was organized in 1902 and quarterly meetings have been held regularly since. No funds have as yet been appropriated by the local legislature for assisting in institute work. Four institutes were held during the past season, consisting of 8 sessions, with an attendance of 200. The cost of these meetings was $30.25. All of the meetings were conducted by members of the experiment station staff. A report of the proceedings has been made and 1,000 copies distributed. The arranging of dates, places, and programmes is left entirely to the president of the institute society. The money for institute purposes has been secured through private subscription.

## IDAHO.

Population, 161,772. Total number of homes, 37,491. Number of farm homes, 17,153. Per cent of farm homes, 45.8. Approximate population in farm homes, 74,091.

Superintendent of institutes.—H. T. French, Director Agricultural Experiment Station, Moscow.

The legislature of 1903 appropriated $2,000 for institute work in Idaho for two years. The control of the institutes and the expendi-

ture of the money are intrusted to the board of regents of the c
of agriculture of the University of Idaho. Seventeen institutes
held during the year, made up of 74 sessions. Thirty-one hu
persons were in attendance. There are 11 lecturers upon the
force, 5 of whom are members of the agricultural college and ex
ment station staffs, who were present at all of the institutes and
tributed sixty-five days of time. Three women's meetings
reported, which were well attended and excited unusual int
The dates, places, and programmes are all arranged by the sup
tendent of institutes, and announcements of the dates, places,
speakers are made from four to eight weeks in advance of the
ings. Brief reports of the discussions are prepared by the secre
published, and sent to the regular mailing list of the experiment
tion and to all of the institute workers in the United States.

The form of local organization consists of an institute comm
in each locality, which serves until another institute is held, and
it is either reappointed or a new one elected. The committe
organized by the election of a chairman at the institute meeting
the appointment of a secretary, together with such special commit
as are needed.

## ILLINOIS.

Population, 4,821,550. Total number of homes, 1,036,158. Number of
homes, 262,388. Per cent of farm homes, 25.3. Approximate populatio
farm homes, 1,219,852.

Superintendent of institutes.—Frank H. Hall, Aurora.

The Illinois Farmers' Institute is organized under a special ac
the legislature and is a public corporation of the State. "It cons
of three delegates from each county of the State, elected annuall
the farmers' institutes of the county," and is managed by a boar
trustees "consisting of the State superintendent of public inst
tion, the professor of agriculture of the University of Illinois,
president of the State board of agriculture, the president of the S
Horticultural Society, the president of the State Dairymen's Asso
tion, and one member from each Congressional district of the S
to be selected by the delegates from the district present at the ann
meeting." The officers of this board of directors are "a presid
vice-president, secretary, treasurer, a State superintendent of fa
ers' institutes, and such other officers or agents as may be dee
proper for organizing and conducting the work of the organizat
all of whom shall hold their office for one year, unless removed soo
by the board, and shall perform such duties as may be required
them by the rules of the board."

Article 5 of the act prescribes the duties of the State superintendent of institutes:

SECTION 1. The State superintendent of institutes shall have general supervision of institute work in the State under the direction of the board of directors and of the executive committee.

SEC. 2. He shall make recommendations as to lines of work which he believes will prove profitable for the ensuing year, together with general plans for their execution and estimates of expenses. He shall make such other recommendations to the board of directors as he may deem for the best interest of the institute work.

SEC. 3. He shall visit the county institute and district conferences when invited to do so by the county institute officers or directors, or when in his judgment the institute work demands such visit.

SEC. 4. He shall have charge of the publication of the annual report and shall insert therein such matters as will advance the agricultural interests of the State, under the direction of the executive committee.

SEC. 5. He shall be librarian of the farmers' institute free libraries, and shall submit to the board of directors or to the executive committee, for approval, lists of books which he deems ought to be purchased for the use of the libraries when such are needed.

SEC. 6. He shall make a detailed annual report in writing to the board of directors, at the last meeting of the old board, of his acts and doings during the year, together with a general summary of the institute work of the State for the year. He shall also make such other reports during the year as the board of directors or executive committee may require.

One hundred and five institute meetings were held last year, 63 being two days and 42 being three or more days. There were 609 sessions. Eighty-two speakers are listed on the lecture force, 17 of whom are members of the agricultural college and experiment station staffs. The total attendance is given by the superintendent as 84,681. An institute was held in every county in the State. The total cost amounted to $18,173. The local organizations in the several counties elect their own officers and formulate their own rules. They are permitted to select their own speakers and to choose such topics for discussion as they believe will be of interest to their respective localities.

Each county farmers' institute is entitled to the sum of $75 per annum on condition "that such institute shall file with the secretary of the Illinois Farmers' Institute a sworn statement which shall show that the said county farmers' institute has held one or more duly advertised sessions annually, of not less than two days each, at some easily accessible location." This statement shall also include "an itemized exhibit of the expenses of the meeting with receipted vouchers therefor, a copy of its printed programme, and the printed proceedings showing the title and author of the papers read and by whom discussed, place or places of meeting with average daily attendance, and such other information as may be called for by the Illinois Farmers' Institute and necessary to successfully assist this work."

The Illinois Farmers' Institute is authorized to award one
scholarship in the college of agriculture, good for two years, for
county in the State, and one for each Congressional district of
cago. The awards are made on the recommendation of the farn
institute director for each Congressional district.

Free circulating libraries are distributed among the several co
institutes. Fifty-one of these libraries have been equipped and
out, each containing about 50 volumes. A round-up meeting of
institute workers was held during the year, lasting through nine
sions, and having an attendance of about 1,000 persons. The su
intendent reports as a new feature of their work the providin
corn-growing contests for boys under 18 years of age. Eight t
sand entered the contest during the past year. The teaching of a
culture in the public schools and the consolidation of rural sch
have been made special features and were discussed at every insti
held throughout the State.

The Illinois Farmers' Institute is required to make an annual re
to the governor of its transactions, which report shall include pa
pertaining to its work and addresses made at the annual meetin
the organization. Twenty thousand copies of this report are requ
to be printed each year, one-half for the use of the Illinois Farm
Institute and the remainder for the secretary of State for distribu
through the members of the general assembly.

## INDIANA.

Population, 2,516,462. Total number of homes, 571,513. Number of
homes, 221,451. Per cent of farm homes, 38.7. Approximate populatio
farm homes, 973,870.

Superintendent of institutes.—W. C. Latta, Professor of Agriculture, Pu
University, Lafayette.

The laws of the State of Indiana require—

> The committee of experimental agriculture and horticulture of the boar
> trustees, together with the faculty of the school of agriculture of Purdue
> versity, to appoint before November 1 of each year suitable persons to
> county institutes in the several counties of the State between the 1st da
> November and the 1st day of April each year, for the purpose of giving to f
> ers and others interested therein instruction in agriculture, horticulture,
> cultural chemistry, and economic entomology.

Section 2 of the act provides that—

> such institutes shall be held at such times and places as said committee
> faculty may determine and under such rules, regulations, and methods o
> struction as they may prescribe: *Provided, however*, That such institutes
> be so conducted as to give to those attending results of the latest investigat
> in theoretical and practical agriculture and horticulture.

Ten thousand dollars per annum has been appropriated for b
ing the expenses of the lecturers and paying such items as may

necessary for the proper conduct of the work. The director of institutes is appointed by the trustees of Purdue University, the present officer being the professor of agriculture in the university and advisory agriculturist of the experiment station.

During the year 175 institutes were held, 165 of which were two-day meetings. The total number of sessions was 832 and the attendance is given at 59,189. The cost was $10,000. The number of lecturers upon the State force was 46, 9 of whom were members of the agricultural college and experiment station staffs, who contributed twelve days of time. The schedule including dates and programmes is arranged by the superintendent, and the places are decided by conference with the local officers. Two State lecturers are provided for each institute with an occasional expert speaker to discuss some special topic. Members of the college and station staffs attend institutes without charge, except for their expenses and at times when their duties do not seriously interfere. An annual conference is held each year, as are also district institutes, comprising a number of counties and for which special programmes are provided. A new feature of the work is a plan for competition by young people at the institutes and at the county fairs. Premiums for exhibits of corn, oats, poultry, butter, and bread, grown or made by young people between the ages of 12 and 20 who live on farms, are offered by one fair association.

The county farmers' institute or home makers' association will duplicate the premiums offered by the fair association upon the following conditions:

(1) The exhibits will be made at the several farmers' institutes to be held in the county during the season as may hereafter be designated.

(2) Each exhibitor must be present in person, submit in writing a description not exceeding 500 words of the method employed in growing the crops or poultry or in making the butter or bread, and read the same at the institute.

(3) Each exhibitor must certify to the area and yield of crop or age and breed of fowls, etc., and that the article was produced by the exhibitor. This certified statement must be attested by two witnesses.

(4) Each person will be permitted to exhibit in but one class and make but a single entry.

A form of constitution for county institute organizations has been recommended and was approved and adopted by 50 of the 92 counties of the State last year. The constitution provides that any resident of the county over 16 years of age may become a member by payment of the annual dues; that the officers shall consist of a president, secretary, assistant secretary, treasurer, and one vice-president for each township in the county. The president, secretary, treasurer, and the several vice-presidents constitute an executive committee, which has charge of the affairs of the association in intervals between the meetings. This committee upon the request of the State superintendent is required to suggest desirable dates and places for farmers' i tutes, themes for speakers, and give such other information as superintendent may desire in arranging the schedule of instit The constitution also provides for "a women's auxiliary for the pose of holding special or separate sessions of the institute women." The advertising of the institute is left entirely to the l organizations, which for this purpose use postals, postal-card grammes, personal letters, and the local press. Six hundred to thousand copies of abstracts of the proceedings are printed and tributed each year.

## INDIAN TERRITORY.

Population, 302,060. Total number of homes, 76,701. Number of f homes, 47,594. Per cent of farm homes, 62.1. Approximate population in f homes, 187,579.

Farmers' institutes have not been organized in the Territory.

## IOWA.

Population, 2,231,853. Total number of homes, 480,878. Number of f homes, 223,525. Per cent of farm homes, 46.5. Approximate populatior farm homes, 1,037,811.

Director of institutes.—J. C. Simpson, Secretary State Board of Agricult Des Moines.

There is no central organization or State superintendent of farm institutes in Iowa, but each county is entitled to organize an instit when forty or more farmers meet and elect a president, secreta treasurer, and an executive committee of not less than three outs of such officers, and hold an institute meeting, remaining in sess not less than two days in each year. Upon presenting proof to county auditor of such organization and such institute having b held, and an itemized statement showing the manner in which money used has been expended, it is the duty of the county auditor certify the statement to the auditor of the State, who upon receipt such certification is required to remit to the treasurer of the cou his warrant not to exceed $75 in any one year. Last year 70 institu were held in 70 out of the 99 counties in the State. The State app priation amounted to $7,425.

The absence of any State organization or board of control has ma it impossible to secure data respecting the work. The secretary the State department of agriculture has contributed the only inf mation that it has been possible to secure. The attendance is e mated at 17,750; the number of sessions at 350, and the amou expended $4,737. No report is published of the institute proce ings.

## KANSAS.

Population, 1,470,495. Total number of homes, 321,947. Number of farm homes, 167,006. Per cent of farm homes, 51.9. Approximate population in farm homes, 763,186.

Director of institutes.—J. T. Willard, Director Agricultural Experiment Station, Manhattan.

The legislature of Kansas of 1903 passed an act providing for the formation of county farmers' institute associations. Such association under this act shall consist of a president, vice-president, secretary, and treasurer, and it must adopt a constitution and by-laws for its government. The county institute association is entitled to the sum of $50 from the county to bear the legitimate expenses of a two-days' institute, and the legislature has provided in addition an appropriation of $2,000 per year to the State agricultural college to be used in paying the expenses of the members of the faculty and experiment station who attend institutes. The duties of State director are performed by the chairman of a committee appointed by the president of the college on institute work. The present official in charge of the institute work is also director of the agricultural experiment station.

Fifty-eight institutes were held during the year. Thirty were one day, 27 were two days, and 1 was continued for over three days. The total attendance was 14,432. The cost of the institutes was $1,541. All of the speakers on the State force were either agricultural college or experiment station officers. Eighteen of these lecturers were engaged in institute work last year, and the total number of days in which they were employed was 336. The chairman of the State institute committee arranges the dates, places, and programmes for institute meetings. The proceedings are not published, except brief abstracts by local papers.

## KENTUCKY.

Population, 2,147,174. Total number of homes, 437,054. Number of farm homes, 234,821. Per cent of farm homes, 53.7. Approximate population in farm homes, 1,153,032.

Director of institutes.—Hubert Vreeland, Commissioner of Agriculture, Frankfort.

Kentucky has no specific farmers' institute law. The work is conducted under authority given in the following extract from the general law prescribing the duties of the State bureau of agriculture:

> The efforts of the bureau shall be directed to the promotion of agriculture, horticulture, etc., and the commissioner shall promote and encourage, as far as practicable, societies and other associations in the several counties and ascertain the agricultural, horticultural, mechanical, commercial, and educa-

tional condition of every county, etc. * * * The commissioner shall put himself in communication with the different agricultural, horticultural, and labor societies, etc.

The sum of $13,000 is annually appropriated to meet the expenses of the bureau of agriculture. Of this sum the commissioner is authorized to expend such amount for institute work as he deems proper. Five hundred dollars was appropriated during the past year for institute purposes. Four institutes were held, composed of eight sessions, and attended by about 1,200 persons. The number of lecturers upon the list is 13, of whom 4 are from the agricultural college and the State experiment station. The proceedings are edited by the State director and printed in supplemental form and circulated by the leading agricultural papers of the State. The county papers also inclose these supplements, distributing them among their subscribers. About 8,000 copies of the proceedings of each institute were printed and circulated in this manner during the past year.

The arranging for institutes in the several counties is in the hands of the superintendent, who cooperates with local farm clubs in arranging the dates, places, and programmes, the State furnishing such lecturers in addition to the local teachers as may be necessary. The places and dates as well as speakers are announced as soon as the programmes have been prepared through the State agricultural papers, as well as by means of local publications. The institute director is the commissioner of agriculture, labor, and statistics for the State. He reports that the main efforts of his business in the future will be in the direction of farmers' institutes and that from $3,000 to $5,000 will be appropriated the next year for institute work.

## LOUISIANA.

Population, 1,381,625. Total number of homes, 284,875. Number of farm homes, 114,214. Per cent of farm homes, 40.1. Approximate population in farm homes, 554,031.

Director of institutes.—J. G. Lee, Commissioner of Agriculture, Baton Rouge.

The farmers' institute work in the State of Louisiana is conducted under a provision of the constitution of 1898, which provides that "the Louisiana State board of agriculture and immigration shall have the control and direction of all State agricultural organizations and State farmers' institutes." In accordance with this provision the State board of agriculture organized a farmers' institute committee, composed of the president of the Louisiana State University, the director of the State experiment station, and the commissioner of agriculture and immigration. Two thousand dollars is annually appropriated for institute work. The commissioner of agriculture and immigration is the executive officer of the State committee on farmers' institutes, and has direct control of the work of organizing and conducting institutes in the several districts.

There are 16 lecturers on the State institute teaching force, 12 of whom are connected with the State college or experiment station. Last year these college and station men contributed 55 days of their time to institute work. Thirty-nine institutes were held during the year, composed of 79 sessions. The total attendance is given at 12,000. The cost of the institutes was $2,156. Three thousand copies of reports of institute proceedings were printed and distributed. Permanent institute clubs with a president and secretary, and with one vice-president from each ward of the parish, constitute the local organization. The institute director cooperates with the local authorities in arranging the dates, places, and programmes for institute meetings. The State director of institutes is appointed by the governor for a period of four years and is also commissioner of agriculture and immigration.

## MAINE.

Population, 694,466. Total number of homes, 163,344. Number of farm homes, 57,153. Per cent of farm homes, 35. Approximate population in farm homes, 243,063.

Director of institutes.—A. W. Gilman, Commissioner of Agriculture, Augusta.

In Maine, under the act creating the State department of agriculture and providing for the appointment of a commissioner of agriculture, the commissioner is required to "hold or cause to be held two farmers' institutes in each county annually, and as many more as the appropriation therefor will allow." An appropriation of $3,000 annually is made for carrying on the institute work and for meeting the expenses of the State dairymen's conference, provided such expense shall not exceed the sum of $500 annually. During the year 37 institutes were held, composed of 79 sessions. The total attendance was 5,473, and the amount expended was $2,500. There are 20 lecturers upon the State institute force. Abstracts of the proceedings are prepared by the commissioner and included in his annual report, of which 6,000 copies are printed.

The commissioner is appointed by the legislature and holds office for two years. The location of the county meetings is made by the county agents, and the dates and programmes are planned by the State director of institutes. The agricultural college and experiment station officers participate in the lecture work whenever desired and at times that do not conflict with their other duties. During the past year three members of the college faculty lectured before institute audiences, giving six days of their time to this service.

## MARYLAND.

Population, 1,188,044. Total number of homes, 242,331. Number of farm homes, 47,089. Per cent of farm homes, 19.4. Approximate population in farm homes, 230,480.

Director of institutes.—W. L. Amoss, College Park.

Under the act of assembly, approved March 27, 1896, establishing farmers' institutes in the State of Maryland, it is provided that the farmers' institute director shall be appointed by the trustees of the Maryland Agricultural College, and that at least "one institute shall be held in each year in each county of the State, and an additional one in each county, if deemed necessary and desirable." The institute under this act was made a department of the Maryland Agricultural College, and by act of assembly, approved April 7, 1900, the sum of $4,000 is annually appropriated for institute purposes. The total number of institutes held during the year was 23, consisting of 71 sessions. Three thousand two hundred and fifty persons were in attendance. Sixteen lecturers are upon the State list of institute instructors, 6 of whom were employed during the past year in giving instruction before farmers' meetings. Three members of the agricultural college and experiment station force contributed five days of time in giving instruction in institute work. The total cost of the institutes for the year was $4,000, and the appropriation for the coming year has been increased to $6,000.

The work in the several counties is conducted by a local committee or county organization wherever such exists, or through a local correspondent appointed by the director of institutes. Reports of the institutes are furnished to the county papers, and enough of these are secured by the director to supply his mailing list. The advertising of the meetings is effected through the newspapers of the State by sending to each a programme about four weeks before the institute in the county in which the newspaper is published is held. The director each year plans a visit of representatives of the institutes in the several counties to some place of special interest outside of the State, as a farm, canning factory, city market, or educational institution, each delegate being expected to write a report of what he has observed during his visit, and present this before the next institute meeting. The results of this method of verifying information have been very satisfactory.

## MASSACHUSETTS.

Population, 2,805,346. Total number of homes, 613,659. Number of farm homes, 36,510. Per cent of farm homes, 5.9. Approximate population in farm homes, 165,515.

Director of institutes.—J. L. Ellsworth, Secretary State Board of Agriculture, Boston.

The farmers' institutes of Massachusetts are held under a general law establishing a board of agriculture which authorizes it to "disseminate useful information in agriculture by lectures or otherwise." By a rule of the State board the secretary of the board is required to provide lecturers for farmers' institutes so far as the appropriation for the object will allow. The board recommends that—

> Whenever any farmers' organization in the State shall desire to have a course of not more than three lectures on any farm subject they may apply to the secretary of the board of agriculture for a lecturer, and the secretary, if he thinks the subject a proper one, shall furnish a lecturer, provided he can secure a competent person to attend on the dates named, and also provided that he has not already been called on during the year to provide lecturers for more than thirteen courses.

One hundred and four institutes, composed of 125 sessions, were held this year. Eleven thousand and thirty-nine persons were in attendance, and there were 78 persons upon the State force engaged in giving instruction at these meetings. The total cost was $1,530, and the appropriation for the coming year is $2,700. The local expenses of the institutes are met by the societies holding the meetings. The dates, places, and programmes for the meetings are arranged by the State director in cooperation with the local officers. The agricultural societies represented on the State board of agriculture are the local organizations under whose auspices the institutes are held. The director of institutes, in commenting upon this feature of their work, states that—

> For Massachusetts, we consider our present arrangement the best one with the institutes under the local control of the incorporated agricultural societies represented on the board who are required to hold three institutes each in every calendar year. They, with the advice and assistance of the central office, select the speakers they wish to hear from the list furnished them by the board, and select the dates most convenient for their people. The board arranges with the speakers to attend these meetings and also meets their expenses, while the societies meet the expenses for hall rent and advertising, and attend to the details of the same. This office maintains a general oversight of the institutes, does not employ any but worthy and instructive speakers, and further endeavors to arrange circuits of institutes with speakers of more than ordinary ability from without the State.

## MICHIGAN.

Population, 2,420,982. Total number of homes, 548,094. Number of farm homes, 202,457. Per cent of farm homes, 36.9. Approximate population in farm homes, 893,342.

Superintendent of institutes.—L. R. Taft, Horticulturist Michigan Agricultural Experiment Station, Agricultural College.

The State board of agriculture is authorized by act of the legislature of 1901 to "hold institutes and to establish and maintain courses of reading and lectures for instruction in the various branches of agriculture, mechanic arts, domestic economy, and the related sciences." The board is authorized to "formulate such rules and regulations as it shall deem proper to carry on the work contemplated in the act, and may employ such agent or agents to perform such d in connection therewith as it shall deem best." Local farmer stitute societies are provided for in the act and such societie required to hold annually at least one institute of at least two da length. To organize a local county institute society, the rule o board requires that at least—

> Twenty residents of the county, without regard to sex, but of legal age, meet and adopt a brief constitution, in harmony with the State law, el president and a vice-president from each township in the county, and a tary, who shall also be treasurer. Such society shall furnish to the secr of the board of agriculture a copy of its constitution and by-laws, and transmit with the same a written agreement, signed by the president an retary of the society, stating that the society will, for purposes of far institutes, conform to the rules of the board of agriculture governing institute. Within ten days after the close of such institute the secretary make a report to the superintendent, on blanks to be furnished by superintendent.

The immediate management of the farmers' institutes is place charge of a superintendent elected by the board of agriculture. superintendent arranges for locating and holding institutes, is aut ized to approve all institute societies when properly organized, after consultation with members of local institute societies, deter the time and place for holding the institutes and the subjects t discussed. He also designates the persons who are to attend as turers, and has authority to reject from the programme local spea or topics that are objectionable. He has authority to call upon faculty and instructors of the agricultural college and members of experiment station force for such institute work as may be assig them by the board, with the consent of the president.

During the past year 291 institutes were held, consisting of 812 sions. Two hundred and eighteen of these institutes were one- and 73 were two-day, and 1 was a three-day institute. The total tendance was 52,236. There were 60 speakers upon the State lect force, 13 of whom were members of the college faculty or of the periment station staff, and contributed sixty-six days of time. appropriation for the expenses of the lecture force was $8,000. A n ber of independent institutes were held, at which there was an mated attendance of 5,000 persons. Reports containing statistic attendance, list of officers, etc., and a report of the annual round institute, together with such papers as are of special excellence at the county institutes, are edited by the State superintendent, 9,000 copies were published for distribution by the institute socie A round-up of the institute workers is held annually. The mee for the past year had a large attendance and continued through sessions.

## MINNESOTA.

Population, 1,751,394. Total number of homes, 342,658. Number of farm homes, 152,393. Per cent of farm homes, 44.5. Approximate population in farm homes, 779,470.

Superintendent of institutes.—O. C. Gregg, Lynd.

The legislature of Minnesota, by act approved April 14, 1903, repealed all former legislation in regard to farmers' institutes in that State and provided for their future constitution, government, and support in an entirely new act composed of fifteen sections. A board of administration is created by the act, consisting of three members of the board of regents of the University of Minnesota, the president of the State Agricultural Society, the president of the State Dairy Association, and the president of the State Horticultural Society, to have charge of the execution of the act regulating the farmers' institute work throughout the State. This board of administration is authorized to appoint a State superintendent of farmers' institutes, whose term of office continues for two years. The board of administration, in conjunction with the superintendent, arranges the institute circuits and determines the times and places where institutes are to be held. The duties of the superintendent are defined as follows:

> To superintend the several institutes when located as herein provided; to engage competent instructors therefor; to receive, examine, and report upon all bills for expenses and services payable from established appropriation, and at the end of each fiscal year to make a detailed report of all farmers' institutes held under his direction, with an itemized account of all expenditures under this act during the year last past, to said board of administration.

The board of administration is directed to prepare and publish each year a farmers' institute annual. Thirty thousand copies of this publication were sent out last year. The law requires that—

> Each meeting shall continue for not less than one day nor more than three days, with morning, afternoon, and, when practicable, evening sessions. Each shall be free to the public, and each shall consist of practical and instructive lectures upon topics pertaining to the farm and home, with incidents and addresses, discussions, and illustrations of such methods and practices as possess real merit and are adapted to the conditions of our agriculture, the sole object and purpose of these institutes being to disseminate practical knowledge upon questions pertaining to agriculture, horticulture, stock and dairy farming, with the least expense and inconvenience to the people of the State.

One hundred and fifty-four institutes were held during the past year, consisting of 378 sessions. One hundred and twenty-nine were one-day and 25 were two-day institutes. The total attendance was 46,210, and the amount of money appropriated and expended was $18,000. There were 13 lectures upon the State teaching force. The college and the experiment station were not represented upon the lecture corps. There are no local county organizations of institutes in the State, the superintendent selecting persons in each locality from year year to assist him in organizing and conducting the local work. women's department of farmers' institutes was organized during tl year.

## MISSISSIPPI.

Population, 1,551,270. Total number of homes, 318,948. Number of far homes, 221,110. Per cent of farm homes, 69.3. Approximate population in fa homes, 1,075,030.

Director of institutes.—J. C. Hardy, President Mississippi Agricultural a Mechanical College, Agricultural College.

Farmers' institute work in Mississippi is under the direction of tl president of the agricultural and mechanical college. There are r laws organizing institutes in the State excepting that appropriati $1,500 to the agricultural and mechanical college for institute wor Last year 107 institutes were held, composed of 214 sessions. O hundred and five were one-day meetings and two were two-day. Tl total attendance was 11,326. Institutes were held in all of tl counties excepting 16. The total cost of the institutes last year w $1,725, and the appropriation for the coming year is $3,000. Twent one lecturers were contributed by the agricultural college and tl experiment station to the lecture service of the institutes. No report of the institute work were published.

The State director organizes the farmers in the several localiti into clubs, and the clubs of each county into a single county club, th county club having charge of the local institute work. He also fix the dates and places for institutes, committing the preparation of th programmes and the arrangement for speakers to the county institute club. Announcement of dates, places, and speakers is mad about one month before an institute meeting is held by publishin the programme in the county papers. The State director is appointe by the board of trustees of the agricultural and mechanical colleg and the appropriation made by the State is payable to this board o trustees. A round-up meeting of institute workers was held thi year at the college, at which 425 farmers were in attendance.

## MISSOURI.

Population, 3,106,665. Total number of homes, 654,333. Number of farn homes, 282,840. Per cent of farm homes, 43.2. Approximate population i farm homes, 1,340,079.

Director of institutes.—George B. Ellis, Secretary State Board of Agriculture, Columbia.

The control of farmers' institutes in Missouri is by law placed i the hands of the State board of agriculture, which is required t "hold farmers' institutes in different parts of the State for the purpose of giving instruction in agriculture." The execution of thi work is placed in the hands of the secretary of the board. One hundred and forty-seven institutes were held during the year, of which 141 were one-day institutes and 5 were two-day. The total number of sessions was 311 and the attendance 30,220. An institute was held in each county of the State. The amount appropriated and expended in meeting the expenses of the institutes was $5,000, all of which is contributed by the State. Twenty-eight speakers were upon the State lecture force, thirteen of whom were furnished by the agricultural college and experiment station.

There are no permanent local organizations for institute purposes in the several counties, the director arranging each year for institutes by correspondence from the office with a local committee, which he appoints. The director fixes the dates and places and consults with the local committee respecting the programme. Meetings are advertised by publishing from two to four weeks in advance the dates, places, and names of the speakers in the local press. A traveling institute was organized three years ago, and was in successful operation during the past season. A railway car is fitted up with illustrative material and equipped with a lecture force furnished by the college of agriculture and mechanic arts of the university and by the experiment station. Numerous districts were visited in this manner and very satisfactory institutes were held, the lecturers having the advantage of the material with which the car was supplied for use in demonstration. In most places where meetings of this character are held the material used in demonstration is taken from the car to the institute hall. After the meeting has been held the people are invited to pass through the car and view the exhibits. The superintendent reports that at one point by actual count 2,500 people passed through the car. The railroads of the State are cooperating in the movement, and the meetings are growing in interest and attendance, as appears from a comparison of the attendance of two years ago, in which 10,000 persons are reported to have been present, with that at the institute last year, when the number was increased to 25,400, and this year to 30,220. Reports of the institutes are published.

A new feature in the institute work adopted last year is reported by the director, its purpose being to interest the children in the public schools. The method pursued is to have the conductor of an institute in a locality, after having secured the consent of the superintendent of public instruction, to interview the school directors of the district, asking permission to have one or more of his lecturers visit the public schools while they are in session and deliver one or more lectures upon some phase of agricultural life. The result has been that the children have become greatly interested in the farmers' institutes, and through them the interest has extended into the homes from which they come.

## MONTANA.

Population, 243,329. Total number of homes, 55,889. Number of farm homes, 13,909. Per cent of farm homes, 24.9. Approximate population in farm homes, 60,588.

Director of institutes.—F. B. Linfield, Director Agricultural Experiment Station, Bozeman.

The board of administration of farmers' institutes in Montana is composed of the governor of the State, the director of the Montana Experiment Station, and the presidents of the Montana Registered Cattle Breeders' Association, the Montana Wool Growers' Association, the Montana Live Stock Association, the Montana Horticultural Society, the Montana State Board of Horticulture, the Montana Agricultural Association, and the Montana Dairymen's Association. The officers of the board consist of a president and secretary elected by the board for two years. The members of this board of administration are designated directors of Montana farmers' institutes, and are "authorized to hold institutes for the instruction of the citizens of the State in the various branches of agriculture and prescribe such rules and regulations as they may deem best for organizing and conducting the same." At least one institute is required to be held in each county each year. The directors are authorized to designate the times and places for holding the meetings. The rules of the board require that—

> The State shall be divided into districts comprising several counties which may be reached by a party of institute workers without unnecessary expense. In one or more districts, which shall be varied each year, a corps of institute workers shall attend and hold a two or three day session in each county. This deputation shall be accompanied by a stenographer, who shall make a full report of their meetings for the farmers' institute annual. The board shall endeavor to encourage by all means in its power the formation of local farmers' institutes, organizations, or farmers' clubs in the various counties or communities of the State. It shall lend such aid as is in its power toward maintaining these organizations and toward helping to make their work efficient and helpful to the communities in which they are organized. It shall also, as far as possible, recognize and use those local organizations in arranging for institute meetings in any locality.

It is further directed that—

> The secretary shall be superintendent of farmers' institutes and shall have immediate charge of and make all arrangements for the farmers' institute work over the State. Such plans and arrangements he shall submit for the approval of the board.

The local county organizations are required to provide suitable halls, and must furnish them with light and heat and bear all necessary advertising expenses.

Four thousand dollars was appropriated for the purpose of conducting institutes this year, of which about $3,000 was expended. Under the new act of March 6, 1903, each institute held under the authority of the board is entitled to a sum not exceeding $50 from the amount appropriated. An institute annual is authorized to be published at a cost not to exceed $1,500 in any one year. Five thousand copies of the proceedings of the institutes of the past year were published and distributed. Forty-four institutes were held during the year, composed of 81 sessions. Four thousand five hundred persons were in attendance, and 18 lecturers were upon the State force, all of whom were supplied by the agricultural college and experiment station. The director of institutes is also acting director of the Montana Agricultural Experiment Station and professor of agronomy, animal husbandry, and dairying in the Montana State College of Agriculture and Mechanic Arts.

## NEBRASKA.

Population, 1,066,300. Total number of homes, 220,947. Number of farm homes, 116,854. Per cent of farm homes, 52.9. Approximate population in farm homes, 564,072.

Director of institutes.—E. A. Burnett, Director Agricultural Experiment Station, Lincoln.

Farmers' institutes in Nebraska are held under the general direction of the industrial college of the University of Nebraska and the agricultural experiment station. The university employs a superintendent of farmers' institutes, who is also the director of the experiment station. There is also employed an assistant superintendent of institutes, who has charge of the field work. Ninety-six institutes were held last year, consisting of 330 sessions. Forty-three institutes were one-day, 49 were two-day, and 4 were three-day. The total attendance was 25,097. Institutes were held in 57 counties. Forty-three lecturers are listed upon the institute teaching force. Fourteen of these were employed during the past year, 10 of whom were members of the agricultural college and experiment station staffs. Six thousand dollars was appropriated for meeting the expenses of the work, of which $5,555 was expended. No report of the proceedings is published. The dates, places, and programmes for the institutes are arranged by the State director. The local county organizations consist of a president, secretary, and an executive committee, who are intrusted with the duties of securing meeting rooms and providing for the payment of the local expenses of the institute. The State lecturers are appointed by authority of the regents of the university, and are assigned to the several localities by the superintendent of institutes. Institutes are advertised through the local papers, by the means of posters, and by the distribution of programmes through the mail. Special attention was given in the institutes last ye corn contest, which was planned for the young people of the and to the improvement of the public roads.

## NEVADA.

Population, 42,325. Total number of homes, 11,190. Number of farm 2,164. Per cent of farm homes, 19.3. Approximate population in farm 8,170.

**Director of institutes.**—Joseph E. Stubbs, President Nevada State Un and Director Agricultural Experiment Station, Reno.

There is no law in this State providing for the organization duct of institutes. The work has hitherto been in charge of the university and the agricultural experiment station, the direc institutes being president of the university and also director experiment station. Last year there were held 4 institutes, com of 18 sessions, with an attendance of 453. The entire expens $83. The State lecture force was made up of 7 members of the cultural college faculty and experiment station staff. The loc ganization consists of a local executive committee with a perm chairman and secretary.

The arranging of dates, places, and programmes is by the st the experiment station after consultation with members of the committee. The railroad companies furnish free transportatio all workers within State limits and grant reduced rates to all attend the institutes. The proceedings of the institute work are lished in the annual report of the experiment station. One thou copies were printed and distributed during the past year.

## NEW HAMPSHIRE.

Population, 411,588. Total number of homes, 97,902. Number of farm 28,271. Per cent of farm homes, 28.9. Approximate population in farm 118,948.

**Director of institutes.**—N. J. Bachelder, Secretary State Board of Agric Concord.

The public statutes of New Hampshire require the secretary o board of agriculture " to make arrangements for, give public noti and, if possible, personally attend the farmers' meetings autho by the board." Under this general authority farmers' institutes been organized and conducted. Last season 18 institutes were composed of 38 sessions. Thirty-four hundred people were i tendance, and 16 lecturers were upon the State corps of instru The total expense was $1,588, all of which was appropriated b State board of agriculture from the general funds received fro State for this purpose. Local arrangements for holding inst are made by the secretary of the board with grange organizations, farm clubs, and agricultural and horticultural societies. Two thousand copies of reports of proceedings were published and distributed.

### NEW JERSEY.

Population, 1,883,669. Total number of homes, 415,222. Number of farm homes, 35,337. Per cent of farm homes, 8.5. Approximate population in farm homes, 160,111.

Director of institutes.—Franklin Dye, Secretary of State Board of Agriculture, Trenton.

The farmers' institutes in New Jersey are organized and conducted under general authority granted to the State board of agriculture by the legislature. Under the act the board is authorized to "employ suitable persons to lecture before the State board of agriculture at its annual or other meetings, and in the counties of the State." The executive committee of the board has delegated the management and conduct of the institutes to its secretary. Thirty institutes were held during the past year, composed of 119 sessions. Fifteen were one-day, 14 were two-day, and 1 was a three-day institute. The total attendance was 4,500. Ten lecturers are upon the State corps of teachers, 8 of whom gave instruction in the institutes during the year. Eighteen hundred dollars was expended for meeting the expenses of institutes, and the same amount has been appropriated for the coming year. No report of the institute proceedings is published except that an occasional summary of the work is printed in the annual report of the State board of agriculture. There are no specific local organizations for institute work in the State. The director invites the members of county boards, granges, and farm clubs to aid him in the work of arranging for the county meetings. In most cases the dates, places, and programmes are prepared by the State director. The local communities are expected to provide proper meeting rooms, and to pay all expenses for heat and light. The director attends most of the institutes, and in many instances takes part as a lecturer. An annual round-up meeting is held in connection with the meeting of the State board of agriculture.

### NEW MEXICO.

Population, 195,310. Total number of homes, 46,355. Number of farm homes, 13,102. Per cent of farm homes, 28.3. Approximate population in farm homes, 55,272.

Director of institutes.—Luther Foster, President College of Agriculture and Mechanic Arts, and Director of the Experiment Station, Mesilla Park.

The farmers' institute work in New Mexico is under the direction of the agricultural college and experiment station. There is no specific legislation providing for the organization or control of the institute work. The expenses are met by appropriations made by the board of regents of the College of Agriculture and Mechanic Arts and of the experiment station. Four institutes were held last year, 3 one-day and 1 two-day. The total number of sessions was 9 and the attendance 160. The State agricultural college and experiment station furnished 15 lecturers, who were employed in the aggregate twenty-one days. The total cost of the institutes for the year was $28.50. No report of the proceedings is published. The citizens in the localities where institutes are held pay all the expenses of the meetings except those incurred by the State lecturers. The advertising of the institutes is committed to the localities in which the meetings are to be held. Wherever there is an agricultural organization in a locality the institute work is conducted through this organization. If no organization exists, then a committee of citizens is appointed to arrange for the meeting. To this organization or committee is committed the preparation of the programme, the selection of local speakers, the fixing of the dates, and the securing of places of meeting.

## NEW YORK.

Population, 7,268,894. Total number of homes, 1,634,523. Number of farm homes, 227,822. Per cent of farm homes, 13.9. Approximate population in farm homes, 1,010,376.

Director of institutes.—F. E. Dawley, Fayetteville.

The director of institutes in New York is appointed by the commissioner of agriculture under the authority of an act of the legislature creating the department of agriculture. The law provides for the appointment of the director of institutes and for the appropriation of funds to conduct them, leaving the manner of organization and management entirely in the hands of the State institute director. Last year 267 institutes were held, made up of 1,154 sessions. One hundred of these were one-day, 163 were two-day, and 4 were three-day institutes. The total attendance was 64,347. Sixty-three lecturers were upon the State corps of instructors, and $20,000 was appropriated for carrying on the work, of which $18,970 was used. A considerable number of independent institutes were held, having an estimated attendance of 35,000 persons. As many as five separate corps of speakers are in the field at the same time. An annual meeting of the lecturers upon the State force has been held for the purpose of normal instruction. During the past year a course continuing for two weeks was provided, one week at the State experiment station at Geneva and one week at the Cornell University. The corps of lecturers was well represented at both of the meetings, and much interest was manifested in the lectures and discussions. The State speakers in New York are all listed under the civil service, and the director reports that there has thus far been no serious trouble from the rulings of their civil-service commission. A special effort has been made to develop institute lecturers from among their own citizens, and the large number of efficient instructors now upon the State force is evidence of the success of the director in this respect.

An annual report of institutes, numbering 25,000 copies, was printed and distributed by the State director and by members of the legislature. The local or county organization varies. Usually a local committee is selected by the State director to have charge of the arrangements for holding the county meetings. The dates, places, and programmes are arranged by the director. Each locality is required to provide a hall free of expense. The State pays the expenses for advertising and for the lighting and heating of the hall. The director frequently furnishes speakers for independent institutes that are held under the auspices of granges, farm clubs, or agricultural societies. The attendance at these independent institutes last year is reported as 35,000. The director reports having held during the season 72 institute sessions specially for farmers' boys and girls with pronounced success. The special topics presented for discussion before all of the institutes were "good roads" and "rural schools."

## NORTH CAROLINA.

Population, 1,893,810. Total number of homes, 370,072. Number of farm homes, 223,831. Per cent of farm homes, 60.5. Approximate population in farm homes, 1,145,755.

Director of institutes.—S. L. Patterson, Commissioner of Agriculture, Raleigh.

By act of assembly it is made the duty of the commissioner of agriculture of North Carolina, by and with the consent and advice of the board of agriculture, "to hold farmers' institutes in the several counties of the State as frequently as may be deemed advisable in order to instruct the people in improved methods in farming, in the beneficial use of fertilizers and composts, and to ascertain the wants and necessities of the various farming communities; and may collect the papers and addresses made at these institutes and publish the same in pamphlet form annually for distribution among the farmers of the State. He may secure such assistants as may be necessary or beneficial in holding such institutes."

Thirty-three institutes were held last year, composed of 71 sessions, and the total attendance was 8,411. Ten instructors were upon the State lecture force, 7 of whom were members of the agricultural college and station staffs. The representatives of these

institutions attended all of the institutes and contributed ninety da
of their time. The total expense for the year was $850, which su
was contributed by the State board of agriculture from revenu
derived from the tax on commercial fertilizers in the State. Tl
director of institutes is also commissioner of agriculture and is elect
by the people for a term of four years. Fourteen hundred dolla
has been appropriated by the board for institute purposes for tl
coming season. An annual report of the proceedings of the inst
tutes, consisting of 27,000 copies, is printed and distributed to tl
regular mailing list of the department of agriculture. The loc
organization for the counties consists of a chairman, secretary, ar
committee on programmes. The director holds institutes upon r
quest of the various localities. The local expenses are provid
for by the community in which the institute is held. Announceme
of the dates, places, and speakers is made by publication in tl
newspapers and through the distribution of posters. A round-t
institute or State farmers' convention was held at the agricultur
college, which continued in session several days and was attend
by about 400 persons.

## NORTH DAKOTA.

Population, 319,146. Total number of homes, 64,690. Number of farm home
44,112. Per cent of farm homes, 68.2. Approximate population in farm home
217,657.

**Director of institutes.**—E. E. Kaufman, Professor of Dairying, North Dakot
Agricultural College, Agricultural College.

The farmers' institute board is provided for by an act of assembl
approved March 19, 1903. The board is composed of the presiden
of the board of trustees of the North Dakota Agricultural College, th
commissioner of agriculture and labor, the director of the experimen
station, the professor of agriculture, and the professor of dairying o
the North Dakota Agricultural College. It is made the duty of th
board to—

> employ a director of farmers' institutes and such other institute lecturers a
> may be deemed necessary; to authorize the holding of not less than 40 insti
> tutes each year, the same to be of such a nature as to instruct the farmers o
> the State in maintaining the fertility of the soil, the improvement of cerea
> crops grown in the State, principles of breeding as applied to domestic animals
> the making and handling of dairy products, the destruction of noxious weed
> and injurious insects, forestry, and growing of fruits, feeding and managemen
> of live stock, and in general such instruction as will tend to promote the pros
> perity, home life, and comfort of the farming population.

The act appropriates $8,000 biennially for carrying on the institut
work. Forty-six institutes were held last year, consisting of 15
sessions. Twenty-three were one-day institutes, and 23 were two-da
institutes. The attendance was 13,567. The number of speaker

upon the State force was 10. Four of these were members of the State agricultural experiment station staff and contributed twenty days of time. The total cost of the institutes was $4,373. Four thousand and sixty-eight dollars was contributed by the State and $305 was received from advertising in the institute annual. The appropriation for the year ending June 30, 1905, is $3,931. The institute proceedings are published in an annual, of which 10,000 copies are distributed at institute meetings and through the mail. The State lecturers are appointed by the institute board. This board also appoints the State director, whose term of office is for one year. An institute committee in each county is selected by the State institute board to look after the advertising and make such special arrangements as are necessary for the successful conduct of the meetings. The dates, places, and programmes are all arranged by the State director, and notices of meetings are advertised by means of large posters, through the publication of the programmes by local newspapers, and by postal card invitations sent out through the mail.

## OHIO.

Population, 4,157,545. Total number of homes, 944,433. Number of farm homes, 280,068. Per cent of farm homes, 29.7. Approximate population in farm homes, 1,237,790.

Director of Institutes.—W. W. Miller, Secretary State Board of Agriculture, Columbus.

The farmers' institute work in Ohio is organized under the provisions of an act of assembly passed April 26, 1890, and amended April 27, 1896. Under this act whenever "twenty or more persons residents of any county in the State organize themselves into a farmers' institute society, adopt a constitution and by-laws agreeable to rules and regulations furnished by the State board of agriculture, and when such society shall have elected proper officers and performed such other acts as may be required by the rules of the State board of agriculture, such society shall be deemed a body corporate." Not more than four farmers' institute societies in any county are permitted to hold annual meetings under the auspices of the State board of agriculture. The secretary of the State board of agriculture has charge of the farmers' institute work under the general direction of the board.

Section 3 of the act provides for the maintenance of farmers' institutes through the levy of a direct tax. Ohio is the only State that has adopted this method of institute support. The section is as follows:

> When a society organized under the provisions of this act shall have held an annual farmers' institute meeting in accordance with the rules of the State board of agriculture, the secretary of said board shall issue certificates, one to the president of the farmers' institute society and one to the president of the

State board of agriculture, setting forth these facts, and on the presentation of these certificates to the county auditor he shall each year draw orders on the treasurer of the county as follows: Based on the last previous national census, a sum equal to three mills for each inhabitant of the county in favor of the president of the State board of agriculture and a sum equal to three mills for each inhabitant of the county in favor of the president of the farmers' institute society, where but one society is organized; but in counties where there are more than one farmers' institute society organized under the provisions of this act and holding meetings under the auspices and by the direction of the State board of agriculture, the said three mills for each inhabitant shall be equally apportioned among such societies, and warrants in the proper amounts issued to the respective presidents, and the treasurer of the county shall pay the same from the county fund: *Provided*, That in no county shall the total annual sum exceed two hundred and fifty dollars: *And provided further*, That the payment to any institute society shall not exceed the expense, as per detailed statement, provided in section four of this act.

The act, it will be seen, provides permanent county institute organization and secures to each a substantial fund for support. The State board of agriculture, under rules which it is authorized to prescribe, gives specific instructions for the formation of local societies and directs how reports shall be made out, and directs the details to be observed in conducting their institute meetings. The State lecturers are required to devote their time and efforts to the discussion of such subjects as are designated by the institute law, namely, "farming, stock raising, fruit culture, and all branches of business connected with the industry of agriculture."

Two hundred and forty-five institutes were held last year, consisting of 1,225 sessions. All of these were two-day institutes, and the attendance was 75,360. The State teaching force consisted of 27 members, and the total expense incurred was $17,580. Twenty thousand copies of reports of the proceedings were printed and distributed. All of the local expenses are met by the counties from their portion of the per capita tax. The dates and places for institutes are arranged by the State director, and the programmes are submitted to him by local societies for approval. The dates, places, and speakers are announced about forty days in advance of December 1, which is the beginning of the institute season. The institutes are advertised locally by the county societies. A number of independent institutes were held during the year by local organizations. The average attendance at each of these is given at 291. A round-up meeting was held last year consisting of four sessions. About 500 farmers were in attendance.

## OKLAHOMA.

Population, 398,331. Total number of homes, 86,908. Number of farm homes, 63,094. Per cent of farm homes, 72.6. Approximate population in farm homes, 289,188.

Director of institutes.—J. B. Thoburn, Secretary Board of Agriculture, Guthrie.

A State board of agriculture, consisting of six elective members and the governor, who is a member ex officio, has been created by a recent act of the Territorial legislature. The six members of this board are elected by delegates from county institutes, which organizations are provided for in the act creating the State board of agriculture. Whenever not less than fifteen farmers, residents in any one county, shall apply to the secretary of the Territory, he is required to issue a charter of incorporation, and the organization shall thereafter be known as the county farmers' institute for such county. These county institutes are required to hold an annual meeting at the county seat, at which matters pertaining to agriculture shall be discussed and one delegate be elected to attend the annual meeting of the State board of agriculture. These delegates at their annual meeting elect two members of the State board of agriculture whose terms are for three years, and the law provides that this board so elected "shall have supervision of the county farmers' institute system." The board elects its secretary and assigns his duties, one of which is the management of the farmers' institutes. The act directs that "it shall also be the duty of the secretary of the board to cooperate with the faculty of the agricultural and mechanical college and the staff of the agricultural experiment station in the preparation of programmes for institute meetings and to attend the annual meeting of each county farmers' institute." The expenses of the delegates from the county institutes to the annual meeting of the board of agriculture are paid by the Territorial treasurer upon warrants drawn by the Territorial auditor, the compensation to be at the rate of $2 per day for not more than three days and 3 cents per mile for each mile necessarily traveled in going to and returning from such meeting.

Last year 52 institutes were held; 28 were one-day, 22 were two-day, and 2 were three-day. The total number of sessions was 129, and the attendance was 5,200. The cost of the institutes was about $1,000, which does not include the salary of the State director. The board of agriculture appropriated $300 and the local organizations contributed the additional amount. There were 8 lecturers upon the State institute force, 6 of whom were members of the State agricultural college and experiment station staffs, who contributed forty-eight days of time. The dates of the institutes are fixed by the county organizations at their annual meetings, and they also assist the State director in preparing programmes. No report of the institute proceedings is published. An annual round-up meeting was held, continuing through five sessions, with an average attendance of 150.

## OREGON.

Population, 413,536. Total number of homes, 91,214. Number of farm home 36,156. Per cent of farm homes, 39.6. Approximate population in farm home 163,760.

**Director of institutes.**—James Withycombe, Director Agricultural Experime Station, Corvallis.

Oregon has no law respecting farmers' institutes. Those that ar held are under the direction of the State agricultural college an experiment station, and the service is altogether voluntary on th part of these institutions. Last year 14 institutes were held; 8 wer one-day and 6 were two-day. The total number of sessions was 4 and the attendance 4,500. The State lecture force is composed chiefl of agricultural college and experiment station men. During the ye four of these officials were in the institute lecture service and co tributed three hundred and fifty-six days of time. The expenses the farmers' institutes were paid from station funds, amounting $350. An appropriation of $500 has been made for the coming yea One independent institute was held, with a reported attendance 300 persons. There is no regular form of organization for the di ferent counties. The director arranges the dates and places aft consultation with individuals in the localities desiring institutes.

## PENNSYLVANIA.

Population, 6,302,115. Total number of homes, 1,320,025. Number of far homes, 225,565. Per cent of farm homes, 17.1. Approximate population in far homes, 1,077,661.

**Director of institutes.**—A. L. Martin, Deputy Secretary of Agriculture, Harrisburg.

Under the Pennsylvania law the deputy secretary of agriculture who is appointed by the governor for a term of four years, is als director of farmers' institutes. He is required to "arrange them i such manner as to time and places of holding the same as to secure the greatest economy and efficiency of service, and to this end h shall in each county where such institutes are to be held confer and advise with the local member of the State board of agriculture, together with representatives duly appointed by each county agricultural, horticultural, and other like organizations, with reference t the appointment of speakers and other local arrangements." Th institutes are supported by biennial appropriations by the legislature to the department of agriculture. The number of institutes held last year was 204. Fifty-nine were one-day institutes, 144 were two-day and 1 was three-day. The total number of sessions was 805, and th attendance was 70,380, not including special meetings. The amount appropriated for institute purposes last year was $17,500. This doe *not* include the salary of the director, $3,000, and that of stenog rapher, $900. There were 54 lecturers upon the State force, 2 of whom were furnished by the State agricultural experiment station, who contributed sixty-two days of time.

Partial reports of institute proceedings are published in the annual report of the department. Thirty-one thousand six hundred copies of this report are published and distributed annually. The local organization consists of a county chairman, who is usually a member of the State board of agriculture, elected by the county agricultural society, and one representative from each of the other county agricultural organizations. All of the expenses of the institute work, including the local expenses in the several counties, are paid out of the State appropriation. The State director fixes the dates and the county committees select the places and prepare the programmes. A number of independent institutes were held during the year by farmers' clubs, granges, and county agricultural societies with an aggregate attendance of about 30,000 persons. The State is divided into five sections for institute purposes and the institute director furnished at least three lecturers for each section.

A round-up meeting of the institute workers is held each year, continuing for from two to three days. A feature of the work in this State has been the prescribing of one or two important topics and requiring them to be placed upon the local programmes for discussion throughout the State. "Nature study in the public schools" and "Centralization" were the two leading topics presented during the past season. The topics selected for the coming year are "Soil fertility" and "Centralized schools." The discovering and training of institute lecturers so as to increase the number of efficient instructors in institute work is made an important feature by the State director.

## PORTO RICO.

Farmers' institutes have not been organized in Porto Rico.

## RHODE ISLAND.

Population, 428,556. Total number of homes, 94,179. Number of farm homes, 5,638. Per cent of farm homes, 6. Approximate population in farm homes, 25,713.

Director of Institutes.—John G. Clarke, Secretary State Board of Agriculture, Providence.

Farmers' institutes in Rhode Island are conducted under authority granted by the general assembly in an act passed May 19, 1892, section 4 of which is as follows:

> The board of agriculture shall hold one agricultural institute in each county annually, either independently or in connection with any society or association of other organization devoted to the same general objects, and may hold as many more as it shall deem expedient, and shall, as far as practicable, encourage State and local associations and societies in the interest of agriculture.

The secretary of the State board of agriculture is charged with the duty of arranging for and holding institutes, the expenses of which are paid by the board out of the $15,000 annually appropriated for the purpose of carrying out the several provisions of the act by which the board is constituted.

Twelve institutes were held during the past year, composed of 21 sessions, with a total attendance of 1,260. The amount appropriated for institute expenses was $600, and the entire cost was $620. Twelve speakers were upon the State lecture force, all of whom were members of the faculty of the State agricultural college or of the experiment station force. The dates, places, and programmes are arranged by the director. Twenty-five hundred copies of reports of the proceedings were printed and distributed.

## SOUTH CAROLINA.

Population, 1,340,316. Total number of homes, 269,864. Number of farm homes, 152,993. Per cent of farm homes, 56.7. Approximate population in farm homes, 759,959.

Director of institutes.—J. S. Newman, Professor of Agriculture, Clemson Agricultural College.

In 1887 the legislature of South Carolina made it obligatory upon the board of agriculture to hold farmers' institutes. A few were held under the provisions of that act. Several years later Clemson Agricultural College was established, and the duties of the board of agriculture, so far as related to the holding of farmers' institutes, were devolved upon the board of trustees of Clemson Agricultural College.

In the Revised Statutes of South Carolina for 1893, section 1132, paragraph 10, the law reads:

> They [the board of trustees of Clemson Agricultural College] shall have power to hold agricultural conventions composed of delegates from each county of the State. * * * ; and to conduct farmers' institutes at such times and places as may appear expedient, and they are authorized to use such parts of funds under their control as may be necessary to meet the expenses of conducting such institutes.

Institutes, therefore, are held under authority granted to the board of trustees of Clemson Agricultural College. A committee of this board makes out the programme for the year and appoints an officer to take charge of the work of conducting the meetings. The rule adopted by the board is to require that an invitation shall be received from not less than fifteen farmers in a locality before an institute will be granted, and it is also required that those desiring institutes must have their petitions in the hands of the president on or before the 10th day of June. These petitions must designate a suitable place for holding the institute, and the locality will be expected to provide either a suitable building or seats in some grove for the comfortable accommodation of those who attend the institute. The director appoints the dates at which the institutes will be held, giving due notice to the petitioners in each locality; thereupon they are expected to advertise the meeting throughout the territory which the institute is to reach. The appropriation for expenses is made by the trustees of the agricultural college from the college and station funds.

Thirty-three institutes were held during the past year, 32 being one-day institutes and 1 three-day. The total attendance was 8,690. Fifteen lecturers were upon the State institute force. Nine were contributed by the agricultural college and 6 by the experiment station. The expenses of the institutes amounted to $600. A round-up institute, extending over 12 sessions, was held at the agricultural college, having a total attendance of about 1,500 persons.

## SOUTH DAKOTA.

Population, 401,570. Total number of homes, 83,536. Number of farm homes, 51,937. Per cent of farm homes, 62.2. Approximate population in farm homes, 249,776.

There has been no appropriation made for farmers' institutes in South Dakota, and consequently no institutes were held during the past year. An effort will be made to secure an appropriation for institute work at the next meeting of the legislature.

## TENNESSEE.

Population, 2,020,615. Total number of homes, 402,536. Number of farm homes, 226,027. Per cent of farm homes, 56.2. Approximate population in farm homes, 1,135,585.

Director of institutes.—W. W. Ogilvie, Commissioner of Agriculture, Nashville.

An appropriation was made by the legislature to the department of agriculture to be used by the commissioner for institute purposes. The commissioner of agriculture selects the lecturers, arranges the programmes, and decides the times and places for holding institute meetings. Seventy-two institutes were held during last year; 20 were one-day, 50 were two-day, and 2 were three-day, with a total attendance of 8,300. The estimated number of sessions is 200. Institutes were held in about three-fourths of the counties. The amount appropriated was $5,000, all of which was expended in institute work.

The State is divided into three distinct geographical sections—eastern, middle, and western Tennessee. Round-up institutes were held in all of these districts, with an aggregate attendance of about 300. No regular report of the institute proceedings is published, but abstracts of the several meetings are printed in the county papers.

## TEXAS.

Population, 3,048,710. Total number of homes, 589,291. Number of farm homes, 341,889. Per cent of farm homes, 58. Approximate population in farm homes, 1,768,251.

Director of institutes.—J. W. Carson, College Station.

The control of the farmers' institute work in Texas is in the hands of the board of directors of the agricultural and mechanical college. Until this year the institutes were held under the direction of an organization known as the Texas Farmers' Institute. The expenses were met by an agricultural paper that paid the salary of a director of institutes and such other expenses as were incurred in carrying on the work.

The legislature of Texas in 1903 made an appropriation of $5,400 to the agricultural and mechanical college for farmers' institute purposes for two years. The past year, therefore, is the first in which the State funds were available, and also the first in which this institution has had direction of the work. A member of the faculty was appointed by the board of directors of the college to take charge of organizing and conducting the institutes.

During the year the director has organized about 150 institutes in the several counties, and also a large number of truck growers' associations. The director and the president of the college arrange the dates, places, and programmes for institute meetings. All of the local expenses are met by the citizens of the community in which the institute is held, including very frequently the entertainment of the State lecturers. One hundred and forty-four institutes were held during the year; 140 of these were one-day institutes, and 4 were two-day institutes. The total number of sessions was 178, and the attendance 15,130. There were 34 lecturers on the State force, 23 of whom were supplied by the agricultural college and experiment station, who contributed 284 days of time. The cost of the institutes for the year was $3,950. Twenty-seven hundred dollars of this was contributed by the State and the balance from an appropriation made by the United States Department of Agriculture out of the boll-weevil appropriation, to be expended under the supervision of the president of the college as collaborator. The main object in making this appropriation was to use the farmers' institute as a means of acquainting the farmers with the most approved agricultural cotton methods, with a view to aiding them in making a cotton crop in spite of the boll weevil, and to induce them to adopt up-to-date methods of farming. The correspondent reports that—

> The localities which seem to be most in need of the service of institutes were carefully selected and distributed over the State, with a view of reaching the greatest number of people. Every device for giving notice of the meetings and for securing a large attendance was employed. Where institutes had already

been organized the service of their members was enlisted, personal letters were written to county officials, to editors of county papers, to prominent, wide-awake farmers residing in the communities, and programmes giving time and places of meetings and list of speakers and subjects were issued. The industrial departments of the various lines of railway along which meetings were held were approached and they readily gave their hearty assistance to the work. In most cases they furnished transportation to the speakers, and in some instances placed private cars at their disposal, and frequently did extensive advertising. The press of the State, daily and weekly papers, rendered invaluable service in giving notice of meetings and in making satisfactory reports of the proceedings.

County organizations are formed under a constitution and by-laws suggested by the State director. By the terms of this constitution the local societies agree to meet once each month for the discussion of agricultural questions. The special topics discussed during the past season were diversification, cotton and cotton insect pests, and swine and sheep growing. Two round-up institutes were held, at which 1,250 persons were in attendance. The publishing and distributing of 10,000 copies of the institute proceedings is contemplated.

There has also been organized in this State a farmers' boys' progressive league, intended to reach the boys and girls out upon the farms and to assist them in the higher forms of agricultural life and practice. Any boy or girl between the ages of 14 and 20 living on the farms or ranches of the Southwest can become a member, and will be entitled to certain privileges which the constitution of the league provides. For the present they are engaged in cultivating crops the seeds for which were furnished by the Texas Farmers' Congress. A report of their work is made to the county farmers' institute, and prizes are offered for products that are specially meritorious.

## UTAH.

Population, 276,749. Total number of homes, 56,196. Number of farm homes, 19,529. Per cent of farm homes, 34.8. Approximate population in farm homes, 96,308.

Director of institutes.—John A. Widtsoe, Director Agricultural Experiment Station, Logan.

Farmers' institutes in Utah are by law under the direction of the trustees of the agricultural college, who, "with the advice of the faculty of said college, are hereby authorized and required to hold institutes for the instruction of the citizens of this State in the various branches of agriculture." There must be held at least one institute in each county during each school year, at such times and at such places as the trustees and faculty of the agricultural college may direct. They are authorized to make such rules and regulations as they deem proper for organizing and conducting institutes, and may employ an agent or agents to perform such work in connection with the faculty of the college. The sum of $1,500 is annually appropriated, to be expended by the board of trustees for institute purpose Under the provisions of this act it is made the duty of those conducting the institutes to encourage and assist in the organization of loca agricultural societies. A course of instruction must be so arrange as to "present to those in attendance the results of the most recen investigations in theoretical and practical agriculture." Fifty-nin institutes were held during the year, consisting of 65 sessions. Al were two-day institutes, excepting three, which were three-day. Th total attendance was 12,000, and the entire cost $1,500, not includin the salary of the State director. Nineteen lecturers were upon th State institute force, all of whom were members of the college faculty or of the experiment station staff. Five thousand copies of the reports of proceedings are printed and distributed. A committee o the faculty, under the direction of the president, arranges for al institute work. The dates, places, and programmes are fixed by thi committee. All the local expenses incurred in holding meetings ar paid out of the State appropriation.

## VERMONT.

Population, 343,641. Total number of homes, 81,462. Number of farm homes 32,871. Per cent of farm homes, 40.4. Approximate population of farm homes 138,830.

Director of institutes.—C. J. Bell, Secretary State Board of Agriculture Hardwick.

The farmers' institute work of Vermont is under the control of th State board of agriculture. This board is composed of the governor, the president of the University of Vermont and State Agricultural College, and three other persons appointed by the governor. They hold office for two years. The board is required to "hold one meeting in each county annually, and others if deemed expedient, and may employ lecturers, essayists, or other aid in conducting said meetings, managing its affairs generally and discharging its duties. At such meetings it shall present subjects for discussion, and, among other topics, forestry, tree planting, roads and road making."

Forty-eight institutes were held during the year, consisting of 125 sessions. Ten thousand persons were in attendance. Eight State lecturers were engaged in giving instruction. Five thousand dollars was appropriated by the State for meeting the expenses, and of this $3,350 was used. The board publishes annually 3,000 copies of its reports, which includes the proceedings of the farmers' institutes. The dates, places, and programmes for institutes are arranged by the State director, who is also secretary of the State board of agriculture. The free use of hall is required to be provided by the community, the State board defraying the other local expenses. Three members of the faculty of the agricultural college assisted in giving instruction.

## VIRGINIA.

Population, 1,854,184. Total number of homes, 364,517. Number of farm homes, 170,412. Per cent of farm homes, 46.8. Approximate population in farm homes, 867,758.

Director of institutes.—G. W. Koiner, Commissioner of Agriculture, Richmond.

Under an act of the legislature of 1893 the board of agriculture of the State of Virginia is required to hold "farmers' institutes at such times and at such places throughout the State as it may deem necessary for the advancement of agricultural knowledge and the improvement of agricultural methods and practices, and publish and distribute such papers and addresses read or made at these institutes as promise to be of value to the farming interests."

The duty of arranging for and conducting farmers' institutes is placed in the hands of the secretary of the board. The only data that it has been possible to secure respecting the institute work in this State is to the effect that 50 counties were visited last year, and the amount of money expended was $3,500. Three or four lecturers attended every institute. The average attendance at the institutes is about 200.

## WASHINGTON.

Population, 518,103. Total number of homes, 113,086. Number of farm homes, 33,931. Per cent of farm homes, 30. Approximate population in farm homes, 155,430.

Director of institutes.—E. A. Bryan, President Washington Agricultural College and School of Science, Pullman.

The law of the State of Washington in defining the purpose of the Washington Agricultural College and School of Science declares that "one of the objects of the State college shall be to hold farmers' institutes at such times and places and under such regulations as the board of regents may determine." An act of the legislature of 1903 requires "that at least one institute shall be held in each county of the State in each year." Fifty-seven institutes were held last year. Twelve were one-day, 44 were two-day, and 1 was three-day. The total number of sessions was 259, and the attendance is given at 15,922. The amount appropriated for institute purposes by the State was $2,500. Twelve speakers are upon the State institute force. Eight of these are from the faculty of the agricultural college and the staff of the experiment station. The president of the college is the superintendent of farmers' institutes, but the dean of agriculture is the field agent and has direct control of the execution of the work. No regular report of the institute proceedings is published, but an institute bulletin is annually prepared and distributed for information.

A round-up or general meeting was held at the time of the meeting of the State Dairy Association. Two hundred and fifty were present.

and six sessions of conference were held. County institute organizations have been established throughout the State, which are intrusted with the duty of making local arrangements for institute meetings.

## WEST VIRGINIA.

Population, 958,800. Total number of homes, 186,291. Number of farm homes, 94,566. Per cent of farm homes, 50.8. Approximate population in farm homes, 487,070.

Director of institutes.—J. B. Garvin, Assistant Secretary of the Board of Agriculture, Charleston.

The law of West Virginia places the control of the farmers' institutes in the hands of the State board of agriculture. Under this act the board is required to "promote and encourage as far as practicable the holding of farmers' institutes, the organization of agricultural and horticultural societies and other associations in the interest of agriculture in the several counties of the State." It is directed to "hold farmers' institutes for the instruction of the farmers of the State in the various branches of agriculture. Such institutes shall be held at such times and places in each year as the said board may direct. The said board shall make such orders and regulations as it may deem proper for organizing and conducting such institutes, and may employ an agent or agents to perform such work in connection therewith as they may deem best." The course of instruction in the institutes shall be so "arranged as to present to those in attendance the results of the most recent investigations, in theoretical and practical farming."

Ninety-seven institutes were held last year. Twenty were one-day and 77 were two-day, together comprising 386 sessions. Twelve thousand and ninety-five persons were in attendance. Twenty-three lecturers were upon the State force, 4 of whom were members of the agricultural college faculty and experiment station staff, who contributed thirty-four days of their time. The amount expended for meeting the expenses of the institutes for the year was $3,456.

There is no law regulating the formation of local institute associations, but the board of agriculture has had prepared a form of constitution and set of by-laws, which were printed in the institute bulletin, with the recommendation that they be adopted by local societies in the several counties. The director of institutes is appointed by the State board of agriculture for a period of two years. The board arranges the dates of the institutes and assigns two of its members to be present at each. The reports of the proceedings of the institutes are required to be sent in to the secretary of the board and are printed in an agricultural periodical issued under the direction of the State board of agriculture.

## WISCONSIN.

Population, 2,069,042. Total number of homes, 436,063. Number of farm homes, 169,531. Per cent of farm homes, 39.8. Approximate population in farm homes, 823,478.

Director of institutes.—George McKerrow, Madison.

The board of regents of the State university is authorized by the law of Wisconsin to "hold institutes for the instruction of citizens of the State in the various branches of agriculture. Such institutes shall be held at such times and at such places as said board may direct. The said board shall make such rules and regulations as it may deem proper for organizing and conducting such institutes, and may employ an agent or agents to perform such work in connection therewith as they may deem best."

One hundred and one institutes were held during the year. One hundred of these were two-day and 1 was three-day, aggregating 512 sessions. The total attendance was 52,000. Thirty lecturers were upon the State teaching force. The amount appropriated for institute expenses was $12,000. Sixty thousand copies of the farmers' institute bulletin, containing the proceedings of the institutes, were published and distributed. The local expenses of the institutes are provided for by the citizens of the community in which the institute is held. The meetings are placed upon request of the various localities. Petitions are sent in to the director of institutes and through these meetings are granted in the discretion of the State director. The arranging of the dates, places, and programmes is in the hands of the institute director, and announcements of the times, places, and speakers are made about one month in advance of the institute season. Special topics for discussion last year were economical feeding, dairy cows, care of milk, tillage, corn, clover, and fertility. The institute director is elected by the board of regents of the university, nominated by the president of the university and dean of the agricultural college, and recommended by the farm committee. He takes a place regularly on the programme as a lecturer, and is in the field during the entire season in which institutes are held. The annual farmers' institute bulletin is a 320-page handbook of practical agriculture. A round-up institute was held extending over 11 sessions, with an attendance of 2,350. The papers and discussions at this meeting are edited and published and make up the material used in the preparation of the annual bulletin or handbook. A number of independent institutes were held, with an estimated attendance of from 2,000 to 3,000 persons.

## WYOMING.

Population, 92,531. Total number of homes, 20,116. Number of farm homes, 5,939. Per cent of farm homes, 29.5. Approximate population in farm homes, 27,296.

Director of institutes.—B. C. Buffum, Director Agricultural Experimer
tion, Laramie.

Farmers' institutes have not been generally organized throu
Wyoming, the work during the past year consisting in a cou
lectures delivered at the university, to which farmers all over the
were invited. The attendance was very satisfactory, and it
pected that the coming legislature will provide for the mainte
of a farmers' institute system by which institutes can be held i
various districts of the State.

*Number of institutes held and the approximate attendance during the year*
*June 30, 1904.*

| State or Territory. | Number of one-day institutes. | Number of two-day institutes. | Number of three or more day institutes. | Total. | Total number of sessions. |
|---|---|---|---|---|---|
| Alabama | 24 | | | 24 | 49 |
| Alaska[a] | | | | | |
| Arizona | | | 1 | 1 | 15 |
| Arkansas[a] | | | | | |
| California | 62 | 49 | 2 | 113 | 380 |
| Colorado | 11 | 2 | 2 | 15 | 36 |
| Connecticut | 18 | | | 18 | 36 |
| Delaware | 18 | | | 18 | 42 |
| Florida | 14 | 1 | | 15 | 32 |
| Georgia | 32 | 1 | 1 | 34 | 68 |
| Hawaii | 4 | | | 4 | 8 |
| Idaho | | 14 | 3 | 17 | 74 |
| Illinois | | 63 | 42 | 105 | 609 |
| Indiana | 10 | 165 | | 175 | 832 |
| Indian Territory[a] | | | | | |
| Iowa | | 70 | | 70 | [b]350 |
| Kansas | 30 | 27 | 1 | 58 | |
| Kentucky | | 4 | | 4 | 8 |
| Louisiana | 39 | | | 39 | 79 |
| Maine | 37 | | | 37 | 79 |
| Maryland | | 23 | | 23 | 71 |
| Massachusetts | 104 | | | 104 | 125 |
| Michigan | 218 | 73 | 1 | 292 | 812 |
| Minnesota | 129 | 25 | | 154 | 378 |
| Mississippi | 105 | 2 | | 107 | 214 |
| Missouri | 141 | 5 | 1 | 147 | 311 |
| Montana | 40 | 4 | | 44 | 81 |
| Nebraska | 43 | 49 | 4 | 96 | 330 |
| Nevada | 3 | 1 | | 4 | 10 |
| New Hampshire | 16 | 2 | | 18 | 38 |
| New Jersey | 15 | 14 | 1 | 30 | 119 |
| New Mexico | 3 | 1 | | 4 | 9 |
| New York | 100 | 163 | 4 | 267 | 1,154 |
| North Carolina | 31 | 3 | 1 | 35 | 71 |
| North Dakota | 23 | 23 | | 46 | 151 |
| Ohio | | 245 | | 245 | 1,225 |
| Oklahoma | 28 | 22 | 2 | 52 | 129 |
| Oregon | 8 | 6 | | 14 | 46 |
| Pennsylvania | 59 | 144 | 1 | 204 | 805 |
| Porto Rico[a] | | | | | |
| Rhode Island | 12 | | | 12 | 21 |
| South Carolina | 32 | | 1 | 33 | |
| South Dakota[a] | | | | | |
| Tennessee | 20 | 50 | 2 | 72 | [b]200 |
| Texas | 140 | 4 | | 144 | 178 |
| Utah | 56 | | 3 | 59 | 65 |
| Vermont | 48 | | | 48 | 125 |
| Virginia | [b]50 | | | [b]50 | [b]100 |
| Washington | 12 | 44 | 1 | 57 | 259 |
| West Virginia | 20 | 77 | | 97 | 386 |
| Wisconsin | | 100 | 1 | 101 | 512 |
| Wyoming[a] | | | | | |
| Total | 1,755 | 1,476 | 75 | 3,306 | 10,622 |

[a] No institutes held.

[b] Estimated.

*Financial statistics of the farmers' institutes for the year ended June 30, 1904.*

| State or Territory. | Funds appropriated. |  | Cost. |  | Appropriations for the season of 1904-5. |
|---|---|---|---|---|---|
|  | State. | College and other funds. | Total cost. | Cost per session. |  |
| Alabama |  | $600.00 | [b] $600.00 | $12.24 | $600.00 |
| Alaska [a] |  |  |  |  |  |
| Arizona |  | 50.00 | [b] 50.00 | 3.33 |  |
| Arkansas [a] |  |  |  |  |  |
| California | $6,000.00 | 1,234.08 | [b] 7,234.08 | 19.00 | 7,234.00 |
| Colorado |  | 517.25 | [b] 517.25 | 14.37 |  |
| Connecticut | 200.00 |  | [b] 200.00 | 5.55 |  |
| Delaware | 750.00 |  | 750.00 | 18.00 | 750.00 |
| Florida |  | 1,240.00 | 1,240.00 | 38.75 |  |
| Georgia |  | 1,000.00 | 1,000.00 | 14.70 | 1,000.00 |
| Hawaii |  | 30.25 | [b] 30.25 | 3.78 |  |
| Idaho | 1,000.00 |  | [b] 1,000.00 | 13.51 | 1,000.00 |
| Illinois | 17,650.00 | 523.79 | 18,173.79 | 29.84 | 17,650.00 |
| Indiana | 10,000.00 |  | 10,000.00 | 12.00 | 10,000.00 |
| Indian Territory [a] |  |  |  |  |  |
| Iowa | 7,425.00 |  | 4,737.00 | 13.53 | 7,425.00 |
| Kansas | 2,000.00 |  | [b] 1,541.47 |  | 2,000.00 |
| Kentucky | 500.00 |  | [b] 500.00 | 62.50 | 5,000.00 |
| Louisiana | 2,000.00 |  | [b] 2,156.00 | 27.29 | 2,000.00 |
| Maine | 2,500.00 |  | [b] 2,500.00 | 31.62 | 2,500.00 |
| Maryland | 4,000.00 |  | 4,000.00 | 56.33 | 6,000.00 |
| Massachusetts | 1,530.00 |  | [b] 1,530.49 | 12.24 | 2,700.00 |
| Michigan | 8,000.00 | 1,825.00 | 9,825.00 | 12.00 | 9,325.00 |
| Minnesota | 18,000.00 |  | 18,000.00 | 47.61 | 18,000.00 |
| Mississippi | 1,500.00 | 225.10 | [b] 1,725.10 | 8.00 | 3,000.00 |
| Missouri | 5,000.00 |  | 5,000.00 | 16.00 | 5,000.00 |
| Montana | 4,000.00 |  | [b] 3,000.00 | 37.00 | 4,000.00 |
| Nebraska | 6,000.00 |  | 5,555.57 | 16.83 | 6,000.00 |
| Nevada |  | 83.00 | [b] 83.00 | 8.30 |  |
| New Hampshire | 1,588.73 |  | [b] 1,588.73 | 41.80 | 1,500.00 |
| New Jersey | 1,800.00 |  | 1,800.00 | 15.12 | 1,800.00 |
| New Mexico |  | 28.50 | [b] 28.50 | 3.16 |  |
| New York | 20,000.00 |  | 18,970.00 | 16.43 | 20,000.00 |
| North Carolina | 800.00 |  | [b] 850.00 | 11.97 | 1,400.00 |
| North Dakota | 4,068.06 | 305.00 | 4,373.06 | 28.96 | 4,000.00 |
| Ohio | 16,747.62 | 832.94 | [b] 17,580.56 | 14.35 | 16,750.00 |
| Oklahoma | 300.00 | 700.00 | [b] 1,000.00 | 7.75 | 300.00 |
| Oregon |  | 350.00 | [b] 350.00 | 7.60 | 500.00 |
| Pennsylvania | 20,500.00 |  | 18,000.00 | 22.36 | 20,500.00 |
| Porto Rico [a] |  |  |  |  |  |
| Rhode Island | 600.00 |  | [b] 620.00 | 29.52 |  |
| South Carolina |  | 600.00 | [b] 600.00 |  | 600.00 |
| South Dakota [a] |  |  |  |  |  |
| Tennessee | 5,000.00 |  | 5,000.00 | 25.00 | 5,000.00 |
| Texas | 2,700.00 | 1,250.00 | 3,950.00 | 22.19 | 15,130.00 |
| Utah | 1,500.00 |  | [b] 1,500.00 | 23.00 | 1,500.00 |
| Vermont | 5,000.00 |  | 3,350.00 | 26.80 | 5,000.00 |
| Virginia | 3,500.00 |  | 3,500.00 | [c] 35.00 | [c] 3,500.00 |
| Washington | 2,500.00 |  | [b] 2,500.00 | 9.65 | 2,500.00 |
| West Virginia | 4,556.71 |  | [b] 4,556.71 | 11.80 |  |
| Wisconsin | 12,000.00 |  | 12,000.00 | 23.43 | 12,000.00 |
| Wyoming |  |  |  |  |  |
| Total | 201,216.12 | 11,394.91 | 203,066.56 | 910.21 | 223,164.00 |

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[a] No institutes held.
[b] Salary of director and of college and experiment station speakers not included.
[c] Estimated.

*Comparative statement of farmers' institutes.*

| State or Territory. | Appropriations. | | | Number of sessions | | Number of institutes. | | | Attendance. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1901-2. | 1902-3. | 1903-4. | 1902-3. | 1903-4. | 1901-2. | 1902-3. | 1903-4. | 1901-2. | 1902-3. | 190 |
| Alabama | $600 | $600 | $600 | 50 | 49 | 24 | 22 | 24 | 2,166 | 2,618 | 3, |
| Alaska[a] | | | | | | | | | | | |
| Arizona | | 60 | 50 | 20 | 15 | 2 | 2 | 1 | 350 | 1,000 | |
| Arkansas[a] | | | | | | | | | | | |
| California | 4,000 | 4,000 | 7,234 | 254 | 380 | 63 | 60 | 113 | 20,000 | 20,000 | 43, |
| Colorado | | 385 | 517 | 20 | 36 | 15 | 10 | 15 | | 1,300 | 1, |
| Connecticut | | 700 | 200 | 25 | 36 | 12 | 9 | 18 | 5,000 | 4,000 | 2, |
| Delaware | 600 | 800 | 750 | 67 | 42 | 15 | 28 | 18 | 3,055 | 4,800 | 3, |
| Florida | 2,500 | 2,500 | | 42 | 32 | 22 | 21 | 15 | 3,300 | 2,900 | 1, |
| Georgia | | 1,000 | 1,000 | 32 | 68 | | 15 | 34 | | 3,500 | 7, |
| Hawaii | | 35 | 30 | 4 | 8 | 4 | 4 | 4 | 180 | 160 | |
| Idaho | 500 | 1,000 | 1,000 | 75 | 74 | 50 | 17 | 17 | 17,000 | 2,550 | 3, |
| Illinois | 18,150 | 18,150 | 18,173 | | 609 | 110 | 108 | 105 | 39,187 | 42,876 | 84, |
| Indiana | 10,000 | 10,000 | 10,000 | 858 | 832 | 201 | 181 | 175 | 40,000 | 73,653 | 59, |
| Indian Ter.[a] | | | | | | | | | | | |
| Iowa | 7,425 | 7,425 | 7,425 | 348 | [b]350 | 65 | 64 | 70 | 6,500 | 17,750 | [b]17, |
| Kansas | 2,000 | 2,000 | 2,000 | 204 | | 102 | 92 | 58 | 32,450 | 38,085 | 14, |
| Kentucky | | 1,200 | 500 | | 8 | | 8 | 4 | 1,600 | 2,000 | 1, |
| Louisiana | 2,000 | 2,000 | 2,000 | 134 | 79 | 38 | 50 | 39 | 7,500 | 13,245 | 12, |
| Maine | 3,500 | 3,000 | 2,500 | 83 | 79 | 37 | 40 | 37 | 5,920 | 5,846 | 5, |
| Maryland | 4,000 | 4,000 | 4,000 | 116 | 71 | 36 | 40 | 23 | 1,500 | 11,222 | 3, |
| Massachusetts | | 2,000 | 1,530 | 154 | 125 | 128 | 120 | 104 | 2,176 | 12,487 | 11, |
| Michigan | 7,500 | 7,500 | 9,825 | 885 | 812 | 255 | 284 | 292 | 101,000 | 58,037 | 52, |
| Minnesota | 16,500 | 16,500 | 18,000 | 238 | 378 | 69 | 100 | 154 | 27,205 | 35,171 | 46, |
| Mississippi | 1,500 | 1,500 | 1,725 | 122 | 214 | 40 | 58 | 107 | 8,000 | 10,000 | 11, |
| Missouri | 4,000 | 4,000 | 5,000 | | 311 | 104 | 127 | 147 | 10,000 | 25,400 | 30, |
| Montana | 2,000 | 2,000 | 4,000 | 32 | 81 | 17 | 16 | 44 | 1,200 | 600 | 4, |
| Nebraska | 4,000 | 4,000 | 6,000 | 268 | 330 | 86 | 65 | 96 | 25,800 | 25,000 | 25, |
| Nevada | | 120 | 83 | 18 | 10 | 1 | 3 | 4 | | 983 | |
| New Hampshire | | 1,000 | 1,588 | 36 | 38 | 40 | 18 | 18 | 4,000 | 6,300 | 3, |
| New Jersey | 600 | 2,000 | 1,800 | 119 | 119 | 17 | 31 | 30 | 5,000 | 6,850 | 4, |
| New Mexico | | 125 | 28 | 13 | 9 | | 3 | 4 | | 375 | |
| New York | 20,000 | 20,000 | 20,000 | 1,363 | 1,154 | 269 | 312 | 267 | 94,688 | 138,528 | 64, |
| North Carolina | 322 | 600 | 850 | 25 | 71 | 17 | 15 | 35 | 1,700 | 1,525 | 8, |
| North Dakota | 1,500 | 1,500 | 4,000 | 67 | 151 | 27 | 19 | 46 | 9,967 | 2,655 | 13, |
| Ohio | 16,784 | 16,981 | 16,747 | 1,250 | 1,225 | 278 | 263 | 245 | 94,655 | 81,752 | 75, |
| Oklahoma | | 1,000 | 1,000 | 36 | 129 | 11 | 29 | 52 | 1,150 | | 5, |
| Oregon | | 300 | 350 | 60 | 46 | 19 | 20 | 14 | 3,335 | 4,000 | 4, |
| Pennsylvania | 15,000 | 15,000 | 20,500 | 831 | 805 | 189 | 327 | 204 | 144,431 | 112,550 | 70, |
| Porto Rico[a] | | | | | | | | | | | |
| Rhode Island | | 44 | 600 | 1 | 21 | 1 | 1 | 12 | 30 | 20 | 1, |
| South Carolina | 1,051 | 1,150 | 600 | 50 | | 31 | 50 | 33 | 10,100 | 14,300 | 8, |
| South Dakota[a] | | | | | | | | | | | |
| Tennessee | 2,016 | 2,500 | 5,000 | | [b]200 | | 40 | 72 | | 10,000 | 8, |
| Texas | | 2,100 | 3,950 | 180 | 178 | | 64 | 144 | | 5,376 | 15, |
| Utah | 1,500 | 1,500 | 1,500 | 40 | 65 | 44 | 40 | 59 | | 3,200 | 12, |
| Vermont | 4,000 | 5,000 | 5,000 | 108 | 125 | 50 | 41 | 48 | 10,000 | 16,400 | 10, |
| Virginia | | | 3,500 | 144 | [b]100 | 47 | 72 | [b]50 | 14,100 | 18,000 | [b]10, |
| Washington | | 2,500 | 2,500 | | 259 | 31 | 12 | 57 | 1,500 | 1,800 | 15, |
| West Virginia | 5,000 | 5,451 | 4,556 | 632 | 386 | 75 | 158 | 97 | 15,000 | 15,750 | 12, |
| Wisconsin | 12,000 | 12,000 | 12,000 | 566 | 512 | 122 | 120 | 101 | 48,800 | 55,000 | 52, |
| Wyoming[a] | | | | | | | | | | | |
| Total | 170,548 | 187,226 | 210,211 | 9,570 | 10,622 | 2,764 | 3,179 | 3,306 | 819,545 | 904,654 | 841, |

[a] No institutes.

[b] Estimated.

*Number of lecturers employed by the State directors of farmers' institutes during the year ended June 30, 1904.*

| State or Territory. | Total number of lecturers on the State force. | Number of members of agricultural college and experiment station staffs engaged in institute work. | Number of days contributed to institute work by the agricultural college and experiment station staffs. | Total number of days of institutes held during the year. | Reports of proceedings. Published. | Reports of proceedings. Number of copies. |
|---|---|---|---|---|---|---|
| Alabama | 9 | 7 | ........... | 24 | No | ........... |
| Alaska[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| Arizona | 3 | 3 | 15 | 14 | No | ........... |
| Arkansas[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| California | 20 | 10 | 340 | 166 | Yes | 12,500 |
| Colorado | 11 | 12 | 48 | 21 | No | ........... |
| Connecticut | 29 | 12 | ........... | 18 | No | 5,000 |
| Delaware | 14 | 2 | 18 | 18 | Yes | 5,000 |
| Florida | 19 | 2 | 18 | 16 | Yes | 3,000 |
| Georgia | 8 | 8 | 82 | 37 | Yes | 2,000 |
| Hawaii | 9 | 4 | 8 | 4 | Yes | 1,000 |
| Idaho | 11 | 5 | 65 | 37 | Yes | 5,000 |
| Illinois | 82 | 17 | ........... | 252 | Yes | 20,000 |
| Indiana | 46 | 9 | 12 | 340 | Yes | 600 |
| Indian Territory[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| Iowa | ........... | ........... | ........... | 140 | No | ........... |
| Kansas | 19 | 18 | 336 | 87 | No | ........... |
| Kentucky | 13 | 4 | 4 | 8 | Yes | 8,000 |
| Louisiana | 16 | 12 | 55 | 39 | Yes | 3,000 |
| Maine | 20 | 3 | 6 | 37 | Yes | 6,000 |
| Maryland | 16 | 3 | 5 | 46 | Yes | ([b]) |
| Massachusetts | 78 | ........... | ........... | 104 | No | ........... |
| Michigan | 54 | 13 | 66 | 367 | Yes | 9,000 |
| Minnesota | 18 | ........... | ........... | 179 | Yes | 30,000 |
| Mississippi | 17 | 21 | 48 | 109 | No | ........... |
| Missouri | 26 | 13 | ........... | 154 | Yes | 7,000 |
| Montana | 18 | 18 | ........... | 48 | Yes | 5,000 |
| Nebraska | 26 | 10 | 52 | 158 | No | ........... |
| Nevada | 6 | 7 | 82 | 5 | Yes | 1,000 |
| New Hampshire | 16 | 4 | 11 | 29 | Yes | 2,000 |
| New Jersey | 10 | 2 | ........... | 46 | No | ........... |
| New Mexico | 9 | 15 | 21 | 5 | No | ........... |
| New York | 63 | 20 | 192 | 438 | Yes | 25,000 |
| North Carolina | 10 | 7 | 90 | 40 | Yes | 27,000 |
| North Dakota | 10 | 4 | 20 | 69 | Yes | 10,000 |
| Ohio | 33 | ........... | ........... | 490 | Yes | 20,000 |
| Oklahoma | 8 | 6 | 48 | 78 | No | ........... |
| Oregon | 9 | 4 | 35 | 20 | No | ........... |
| Pennsylvania | 58 | 2 | 62 | 850 | Yes | 81,600 |
| Porto Rico[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| Rhode Island | 12 | 12 | 24 | 12 | Yes | 2,500 |
| South Carolina | 10 | 15 | 30 | 35 | No | ........... |
| South Dakota[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| Tennessee | 6 | ........... | ........... | 126 | No | ........... |
| Texas | 16 | 23 | 284 | 148 | Yes | 10,000 |
| Utah | 10 | 19 | 120 | 65 | Yes | 5,000 |
| Vermont | 24 | 3 | ........... | 48 | Yes | 3,000 |
| Virginia | 6 | ........... | ........... | [c] 50 | ........... | ........... |
| Washington | 12 | 8 | ........... | 103 | No | ........... |
| West Virginia | 23 | 4 | 34 | 174 | Yes | 10,000 |
| Wisconsin | 25 | ........... | ........... | 103 | Yes | 60,000 |
| Wyoming[a] | ........... | ........... | ........... | ........... | ........... | ........... |
| Total | 953 | 361 | 2,131 | 4,843 | ........... | 329,200 |

[a] No institutes.

[b] Abstract mailed.

[c] Estimated.

# COUNTY SCHOOLS OF AGRICULTURE IN WISCONSIN.[a]

By K. C. Davis,

*Principal of the Dunn County School of Agriculture, Menomonie, Wis.*

Since county schools of agriculture were opened in the State of Wisconsin in the year 1902, this class of schools has been watched with much interest. They have truly been on trial in the public mind. The progress of these schools has been one of the most interesting educational problems since the establishment of the so-called land-grant colleges for the teaching of agriculture and the mechanic arts. This new step in the extension of agricultural education to the masses was one which made the educators of the country look on with mingled doubt and hope—doubt that the new schools established on a county basis could be a success; hope that their experience, if successful, would lead other counties and States to undertake similar schools. A study of these schools after two years of successful operation, with reference to their equipment, courses of study, and influence upon adjacent agricultural communities, should be of interest and value to those who are considering secondary instruction in agriculture for other communities.

## EQUIPMENT OF THE SCHOOLS.

The schools have been equipped at the expense of the counties where they are located. This is true as to buildings, furniture, apparatus, machinery, and stock. But the State aids each school to the extent of $4,000 a year, to be applied to the running expenses. The total running expense thus far has been only $6,000 a year for each school.

### FARMS AND GROUNDS.

The Dunn County School of Agriculture has its chief buildings located on a half block in the center of Menomonie, the county seat.

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[a] Descriptions and illustrations of the work and equipment of these schools have appeared in the following articles: Progress in Secondary Education in Agriculture, U. S. Department of Agriculture Yearbook 1902, pp. 482–500; Some Features of Recent Progress in Agricultural Education, U. S. Department of Agriculture, Office of Experiment Stations, Annual Report 1902, pp. 416–459; Progress in Agricultural Education, 1903, U. S. Department of Agriculture, Office of Experiment Stations, Annual Report 1903, pp. 571–634.

Here there is still room for poultry runs and a small gar girls. Philanthropic citizens and the city gave these ground school. The location in the center of the city avoids lon between school and boarding places during the winter seaso farm area of 6 acres is located on the county fair grounds, mile from the school. Here the boys of the school have pr farm, orchard, and nursery work during the spring term. T may easily be increased from time to time. The Dunn Coun allows the students to board in private homes near the sch they are required to do their farm work nearly a mile aw Marathon County the school building is located on a 7-ac near the fair grounds, and near the city of Wausau. This the students to walk some distance from their boarding place school, but their farm work is quite close to the school build

Gifts of the necessary amount of land for the purposes schools have been made by citizens or communities to de the location of the institutions in each case.

## BUILDINGS.

The agricultural school in Marathon County is provided w building 42 by 96 feet, built of brick and three stories high building has a one-story wing extending to the rear, about 2 feet, and used for shopwork and hothouse purposes.

In Dunn County the agricultural school has four buildings: building, mechanical building, horticulture building, and fa house.

The main building is almost like the Marathon County b and a description of it may be of value to others. The fi second floors are devoted to the uses of the school of agricultu the third floor to the county teachers' training school. The bu is divided into apartments as follows:

*Lower floor.*—General laboratory, 20 by 40 feet, in whi mentary science is taught; sewing and lecture room, 20 by 3 with blackboard suitable for class work, and curtained for stereopticon when desired; laundry and bathroom, 14 by 3 dynamo room, 11 by 14 feet; men's wash room, 12 by 12 feet; and dressing room, 14 by 14 feet, and four ventilating rooms.

*Second floor (which is the one reached by the main entran* Assembly and study room, 40 by 40 feet, capacity for 90 single kitchen, 19 by 32 feet; dining room, 19 by 20 feet; principal's and library, 14 by 16 feet, with book shelves on four sides whe agricultural library is kept; ladies' cloak room, 8 by 11 fee telephone room, 3 by 12 feet.

*Third floor.*—Assembly room, two recitation rooms, prin office, book closet, retiring room for ladies, and ladies' toilet ro

The attic is unfinished but is used as a recreation room in inclement weather.

The mechanical building of the Dunn County school is 24 by 50 feet, two stories high over a high bank basement. The basement is divided by a brick partition, one room being used by blacksmith classes and the other by classes in dairying. The main story is all used for instruction in carpentry. The upper story is for storage of dry lumber and other purposes. The superstructure of this building was given by Senator J. H. Stout and moved to the present site.

The horticulture building is two stories high over a bank basement. The basement story is what gives the building its name, as it is used for potting plants, grafting and budding lessons, winter storage of scions, roots, bulbs, and tender plants. The main story has a poultry department 18 by 28 feet, and a large room for keeping and exhibiting machinery and tools used by the school on the farm and garden. The upper story is one room 28 by 50 feet and 15 feet high. It is used for basket ball, hand ball, and gymnastic exercises. It may be used for classes when the school grows to need it.

The farm tool house is 12 by 16 feet, one story high, located on the fair grounds near the school farm. It is used to keep tools and implements handy for use on the farm. This building was erected by students in the school.

The probable number of students that could attend either of the agricultural schools at one time is about 125. During each of the first two years the number has reached over half that limit. If the attendance becomes too great, the requirements for admission can be raised or the accommodations increased at very little cost.

## CHARACTER OF THE INSTRUCTION.

In all the instruction in this new class of schools the useful side of the knowledge and training given to students is emphasized. This is the principle on which they are founded. The extended knowledge which the farmer must have should be made as practical as possible. At every point the school is made to cooperate with the farm, the shop, the dairy, and the home. The manual training courses are made far more practical and useful than such courses usually are. Nearly all of the time of the classes has been utilized in making articles of use on the farm, in the home, and in the school and shop. The same feature of useful training has prevailed in the domestic economy, plant life, farm accounts, study of soils, poultry, and in fact all subjects.

The founders of the county agricultural school believe that a progressive farmer should know a great deal more than was known by the farmers of past generations. And in many instances where it is important that farmers should make application of rather new scientific truths the schools have stimulated thought along these lin by simplifying what seem intricate processes have induced th apply the results of experiment station work.

We believe that young people of the country have the right t such knowledge as they gain in a practical school of this Farmers' sons and daughters are just as much entitled to a s training as are the young people of the cities. A special edu is needed for farming as well as for the practice of medicine o

The farm demands men who are prepared in special school as this new line of agricultural high schools being created by co in Wisconsin. Men with the best brains are wanted on the The time is rapidly drawing near when no occupation can be which will demand a better preparation than farming. A knowledge of science, a thorough understanding of basic prin of plant and animal life, a thorough acquaintance with the w markets and how to use them, a clear insight into the reasons u lying all farm operations, a thorough attention to all details business, a steadiness in all matters pertaining to life on the courage to act and act quickly at the proper time, good ph strength and power of endurance—these are some of the qu demanded of the farmer by the farm of to-morrow. Alread hear the call for such men.

The courses of study for these county schools were the resu a careful study of the courses in the State colleges and similar tutions in Europe. These courses were planned by the princip the county agricultural schools and the State superintendent of lic schools, and were published in a special report from the department in January, 1903. Each school has found it nece to modify the courses to suit local conditions.

The regular course covers two years of eight months each, b ning in October and closing in May. Pupils are admitted to course after finishing the work of the rural district or village sc

The winter short course for farmers is completed in two w terms of twelve weeks each. This is offered in the Dunn Co school only.

## METHODS OF INSTRUCTION AND FACILITIES.

In the study of soils the classes use text-books and labor methods. The physical laboratory serves as a suitable place considerable soil work. This is supplemented by experiments i greenhouse and in the grafting room. Numerous experiments, as those suggested in Chapters I to VI of Bailey's Principl Agriculture, are performed by classes.

"*Feeds and Feeding*," the new text-book by Dean Henry, is

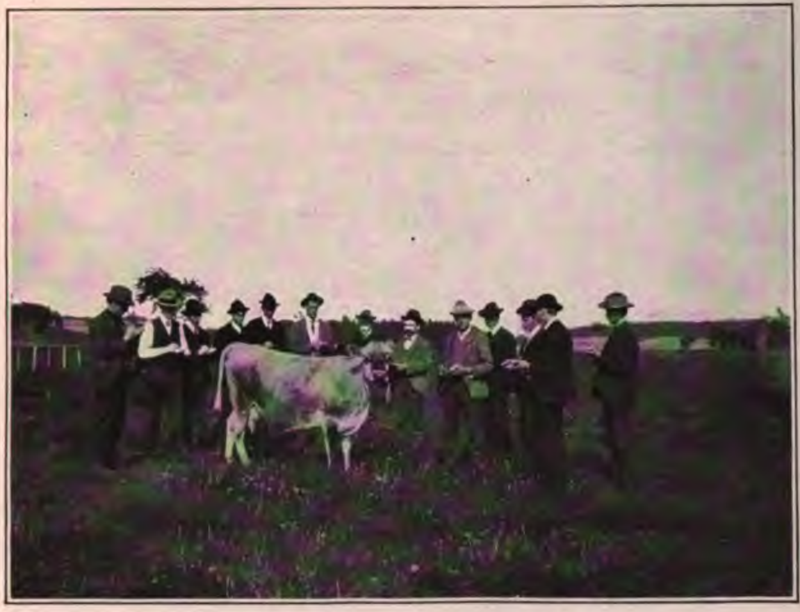

FIG. 1.—STOCK JUDGING, DUNN COUNTY SCHOOL.

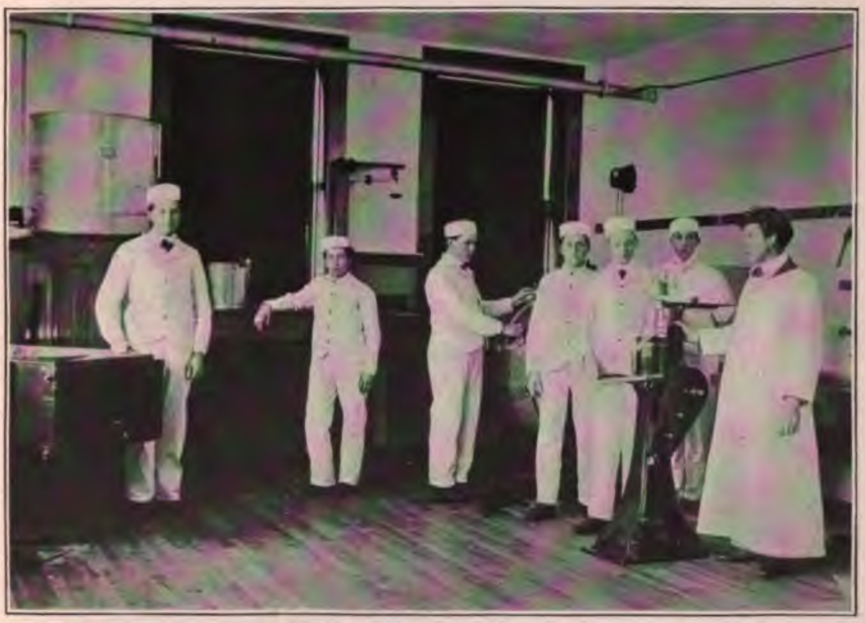

FIG. 2.—DAIRY ROOM OF DUNN COUNTY SCHOOL.

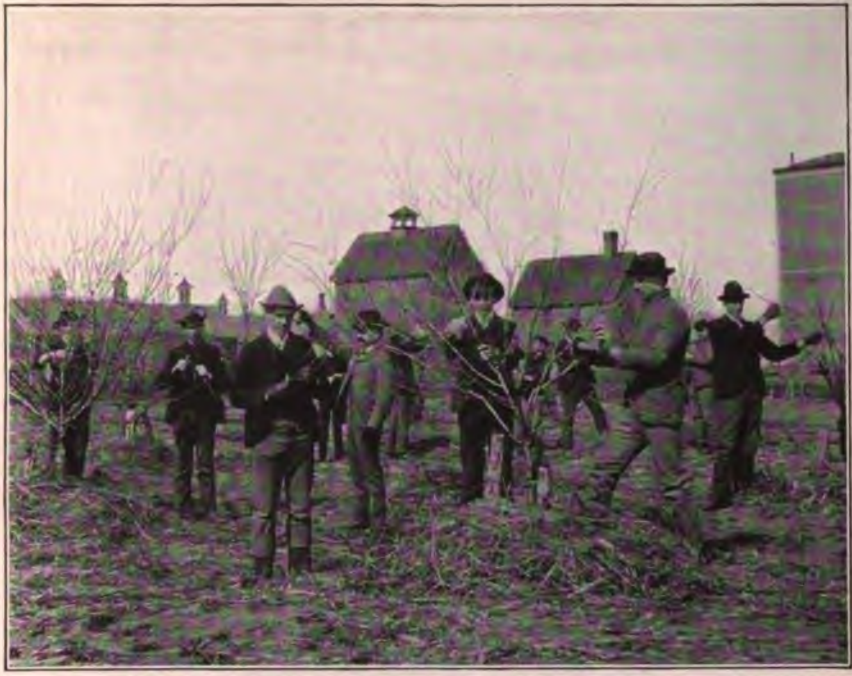

FIG. 1.—PRUNING BY STUDENTS AT DUNN COUNTY SCHOOL.

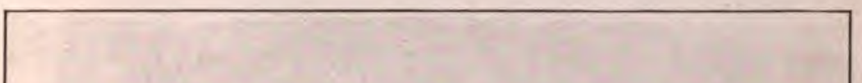

FIG. 2.—STUDENTS OF DUNN COUNTY SCHOOL STUDYING FARM CROPS.

in each county, and the classes go to the county asylum farm near by and to other good stock farms to study methods. The best stockmen in the section are invited to address the classes. This work is all aided by the early experience of the students, who are nearly all from farms.

In the subject called "Care of Animals" Doctor Mayo's text-book is used by the schools. The work is made very practical by trips to the best barns in the county, and by careful examination of many sound and unsound animals of all kinds. Considerable stock judging is carried on by classes in connection with this subject. (Pl. XXXI, fig. 1.) Young farm boys become very familiar with all types of farm animals. No farm animals, except poultry, are as yet owned by the county agricultural schools, though it would be of great help to have barns and stock on the school farms, if funds were available.

Dairying is taught only in the Dunn County Agricultural School, but is soon to be introduced in Marathon County. Full instruction is given in regard to running farm separators and the care of milk and cream. Students receive practical training in the ripening of cream, churning, working and packing of butter, and testing the value of milk by the Babcock test. The practice work is carried on in a well-equipped dairy, containing cream separators, Babcock testers, combined churn and worker, ripening vat, milk heater, scales, and complete set of utensils. (Pl. XXXI, fig. 2.) The sloping cement floor and brick walls make the creamery quite sanitary and modern. Milk is bought from farmers, who haul it to the dairy, and the butter is sold at the highest market price to local customers and stores.

For short-course students the subject-matter varies only a little from the winter-term work in the regular course. This avoids a multiplication of classes. One subject, given only to the short-course students (men), covers the general science of agriculture in a broad way. A suitable text-book is used in this class, and a number of Farmers' Bulletins issued by the U. S. Department of Agriculture are used by means of a topical method of recitation.

A brief time is given to experiments in the laboratory, teaching those principles of physics which are most applicable to farm practice, such as heating, lighting, ventilation, friction and lubricants, principles of pumps, eveners, and pulleys.

At present only a short study is made of the more common chemical elements and their chief compounds. For the young men these lessons lead up to the study of the composition of soils, fertilizers, and feeds. For the young women the elementary chemistry forms a fundamental groundwork for the chemistry of foods.

Farm accounts are kept by a very small proportion of farmers in the West. A very thorough course in this subject has been worked out by the principals of these schools. The students formul accounts in books suitable for home use in all subjects relating to farm work of to-day. A brief study of commercial law of imp tance to farmers is taken up. Business forms, contracts, and la surveying are studied.

Practice in vegetable, flower, and fruit gardening is given both sexes. The land areas already mentioned in this article are us for that purpose. Farm machines of the best types are freely gi by manufacturers for advertising purposes. A few necessary to purchased by the school make the farm equipment quite complete a inexpensive.

In the study of plant life very little of the old-fashioned botani work of the high schools is taken up. Studies in regard to how pla grow, how they feed, their effect upon the soil, lessons in pollinati germination, natural and artificial methods of propagation—as la ering, grafting, budding, and by cuttings—are taken up and supp mented by practice. (Pl. XXXII.) Numerous experiments plant physiology are performed by the students in the laboratory a greenhouse. There is much need of a suitable text-book in plant li At present the subject-matter is gathered from numerous sources.

Poultry quarters are constructed on model plans of economy a cleanliness. The department is supplied with facilities for artific incubation and brooding. Brooders were built by carpentry studen Bone and meat grinders are given by manufacturers. The best ty of farm poultry are kept. A term of lectures on poultry raisi rounds out the practice work in this subject.

Both injurious and beneficial insects are studied from live a dried specimens in the laboratory. A part of the term assigned this work is given to a similar study of diseases of plants. The is considerable practice in making and using spray materials, su as emulsions, poisons, and fungicides. These are applied in t greenhouse, gardens, and private plantations. Students thus becon familiar with different forms of spraying apparatus.

The carpentry is not mere manual training, as taught in hig schools. (Pl. XXXIII, fig. 1.) We call it farm carpentry. Aft the necessary preliminary work the students soon learn the constru tion of buildings, machines, cupboards, paper racks, mail boxe match holders, milk stools, bookcases, and a variety of useful an ornamental articles for the home and farm. In the Dunn Count school the classes in carpentry have ceiled and done the interi finishing of the poultry department and the gymnasium. They ha made the workbenches and tool racks for the carpentry departmen and hardly a week passes without showing the completion of a nun ber of articles for school use. The farm tool house built by t

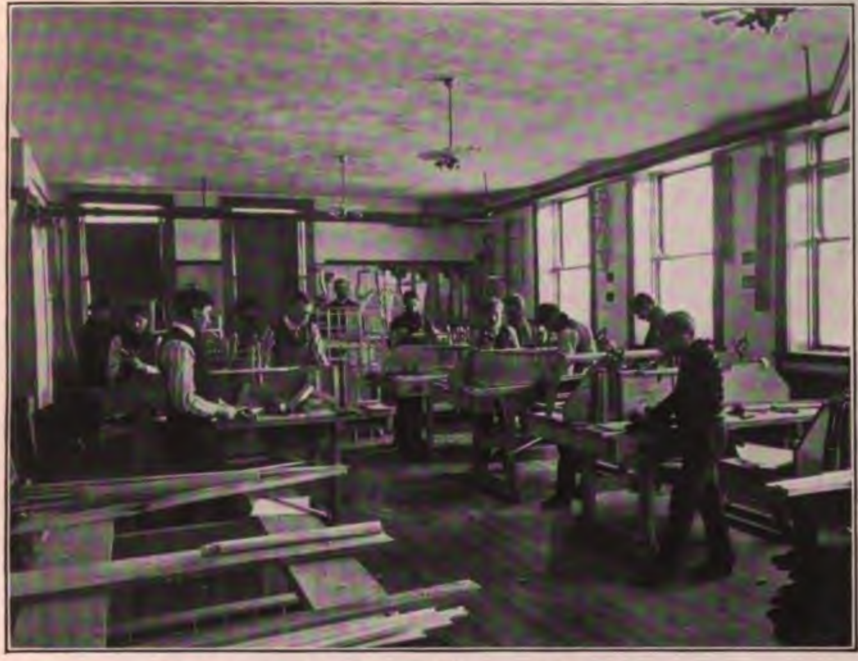

FIG. 1.—CARPENTER SHOP AT MARATHON COUNTY SCHOOL.

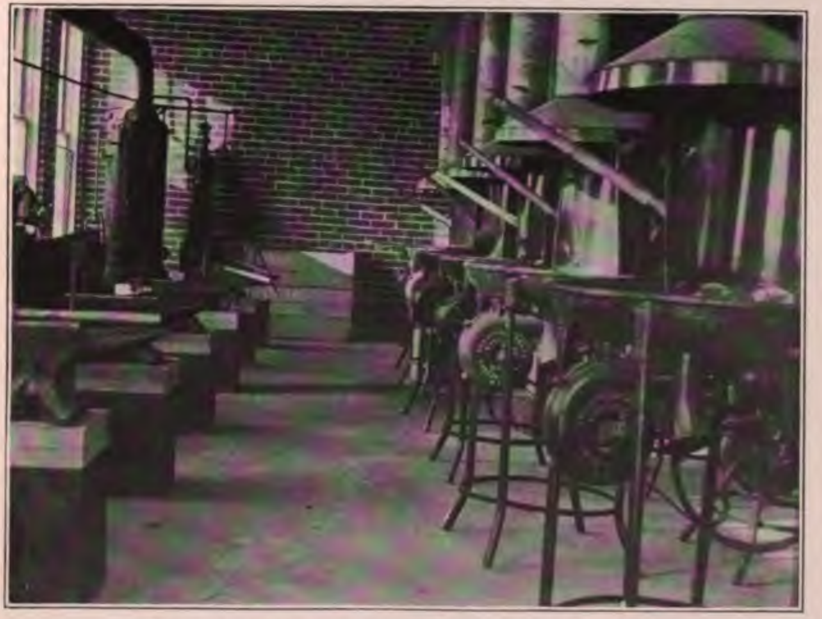

FIG. 2.—BLACKSMITH SHOP OF DUNN COUNTY SCHOOL.

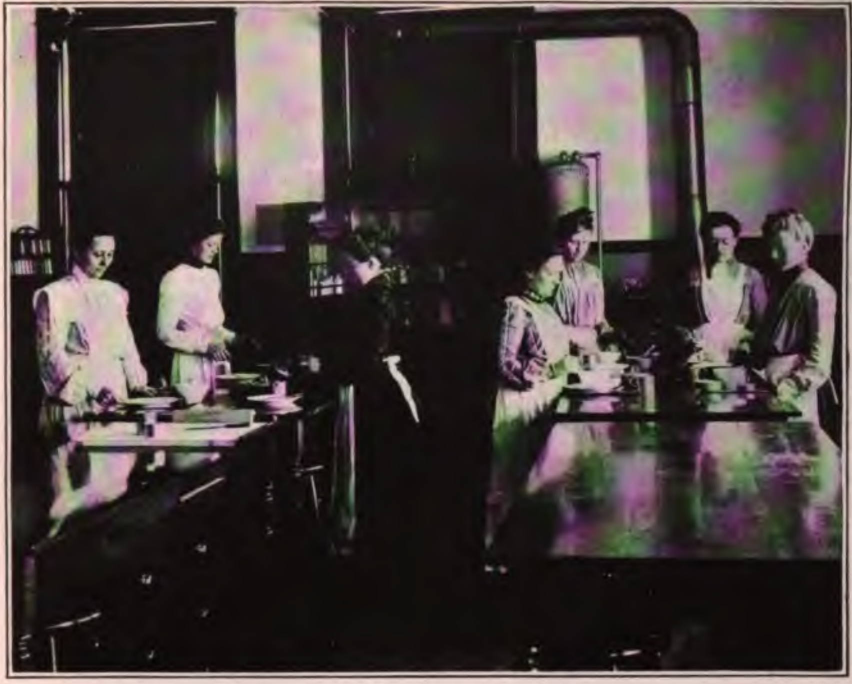

FIG. 1.—KITCHEN OF DUNN COUNTY SCHOOL.

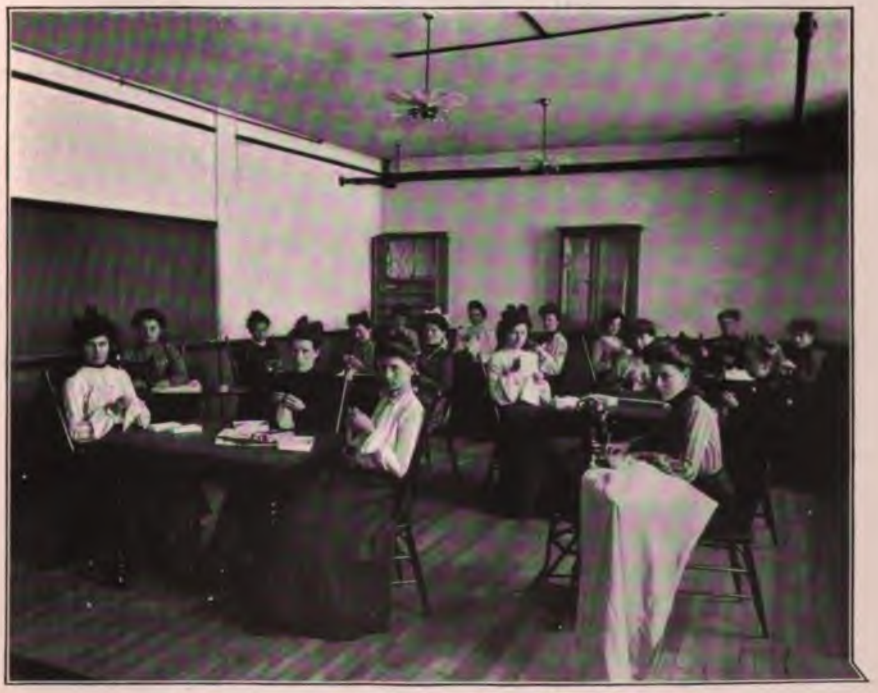

FIG. 2.—SEWING ROOM OF MARATHON COUNTY SCHOOL.

students has already been mentioned. The carpentry departments in both schools are equipped with such tools as should be used in farm shops. It is thought that equipments too elaborate for use on any farm would have a detrimental influence upon the students. Simple, plain tools of the very best quality are used.

The blacksmith department in each school is equipped with portable forges, anvils, and a few simple blacksmith tools for each student. (Pl. XXXIII, fig. 2.) All the work is of a very practical nature. Articles useful on the farm are made, such as clevises, chain links, brackets, cold chisels, punches, rings, tongs, repair parts for machines, and harrow teeth. Practice is given in welding, tempering, sharpening, soldering, and painting.

Incidents of the manual training work are the operation of steam and gasoline engines and other farm machines, splicing and tying ropes, renovating and repairing dilapidated machinery. Students and farmers are encouraged to have farm shops of their own.

Mechanical drawing is practiced in the shop and class room, where working drawings are made for use at the carpenter's bench or to be followed in the construction of farm buildings, such as dwellings, barns, granaries, silos, poultry houses, and machine sheds.

The cooking department is equipped as nearly like a home kitchen as is consistent with the number of students to be accommodated. (Pl. XXXIV, fig. 1.) Wood and gasoline ranges are used instead of individual gas plates. Convenient cupboards and kitchen cabinets are such as should be in any well-equipped home. Even the work tables used by the pupils are models of convenience in every respect. Food sets, showing the composition of each of the standard foods, are conspicuously placed for constant reference and study in the preparation of meals. Students get practice in preparing and serving meals to each other and to numerous visitors. This is supplemented by a series of lectures on "Home Economy," touching upon chemistry of foods, invalid cookery, and hygiene of the person and the home.

In each school the sewing department is equipped with sewing machines, drafting tables, and everything necessary to teach the girls the best methods of making their own garments (Pl. XXXIV, fig. 2). They furnish their own material and use the finished products. They make underclothing, shirt waists, skirts, wool dresses, and do some millinery work.

Well-equipped modern home laundries are used to teach the principles of laundering, with special attention to the removing of fruit and other stains and disinfecting. Special treatment of flannels, silks, fixation of colors, starching, polishing, composition and action of various soaps, soda, bluing, borax, and washing powders.

The courses in "Home Nursing" and "Emergencies" are given means of lectures, with practical illustrations, and are very popula

Academic work is carried on by all students throughout the years. The subjects included under this head are English, libr reading, business arithmetic, United States history, and civil g ernment. Wherever it is possible, as in arithmetic, the subj matter is adapted to farm use.

## ATTITUDE OF STUDENTS.

To show the attitude which the students in these schools h toward them, the following question was asked: "Why sho rural young people attend the Dunn County Agricultural School A few of the replies may be of interest here. "In sewing, one m learn to make her own garments." "We can learn good houseke ing, sewing, laundering, how to plan a house, how to work quic and quietly." "We learn a great deal about the food value of diff ent food materials and the right way of cooking foods." "It off the most practical course in domestic economy of any school I co find." "We learn the effect of diet upon the health and how to p pare foods in the most healthful manner." "We learn the easi quickest, and best way to do our work." "I love housework, and attending this school I have learned many things that will ma it much easier; also many ways to economize time, strength, a money." "Attending this school has made me more interested all work." "I have learned the care and use of all tools used by t farmer." "In my opinion it prepares students for a much m pleasurable and prosperous life." "This school has such a lar range of studies for such a brief course." "To secure practi training in blacksmithing and carpentry." "I came here becau I know that I will become a better farmer and American citizen it." "It is necessary for the future farmer to have a course in su a school to enable him to be the most successful farmer." "It teach how to farm with success, how to keep a farm in good order, wh crops pay the best, and what ones are hardest on the land." " have learned how to run an engine, the proper care of milk and crea and how to make good butter." "The school has helped me to secu twice the wages I could get before." "We learn that a farme life and work are not all drudgery."

Twenty-three students have graduated from these schools—17 fr the regular courses and 6 from the short courses. These gradua are all following agricultural pursuits and are in all cases putti into practice many of the things they learned while in school. Th is a good standard from which to measure the success of these schoo

## POPULARIZING THE SCHOOLS.

The interest shown in this new movement speaks strongly in its favor. County schools of agriculture can not be a success unless the farmers of the vicinity take an abiding interest in them. The experience in Wisconsin shows that the farmers look upon these schools with much favor. They are proud of them. They speak of the schools as "the farmer's best friend," "the best place to send our boys," "the college for the rural classes," and in such complimentary ways only.

The work of these schools has been popularized a great deal, and information concerning their character has been spread not only in the home county, but in surrounding counties. This has been done by means of numerous articles in the newspapers, by exhibits at county fairs each year, by school bulletins published quarterly, and by numerous farmers' meetings. During the first three years the instructors of the Dunn County school held 65 farmers' institutes, or similar meetings, throughout the county. Stereopticons have been used to show the work of the school and to illustrate the principles to be taught. A great many practical subjects have been handled, as in State institutes, thus carrying the work of the school into local communities. The character and value of these farmers' meetings are such as to put the farmers of the section into harmony with the new movement. They have full confidence in the school.

## CORRELATIVE WORK OF THE SCHOOLS.

Much agricultural information is disseminated from the agricultural school to the farmers of the county. Directions for planting; suggestions as to varieties; combating noxious weeds; helping establish cooperative creameries; planning barns, silos, schoolhouses, dwellings; devising ventilators; selecting stock, and many other subjects are taken up by the instructors with individual farmers. The schools have done a great deal of milk and cream testing for farmers for the purpose of helping to improve dairy herds. The school farms try such new crops as should be used by those living in the section. When these schools are more widely established throughout the country, they will be important factors for the proper distribution of Government and State bulletins. Many hundreds of bulletins on special farm topics have been placed in the hands of farmers desiring information on these subjects.

A novel feature of the school's work in Dunn County is the introduction, through the rural teachers, of elementary agriculture and manual training into district schools of the county. By an interchange of classes with the county training school the agricultural

school teaches the rural teachers to handle these subjects in
schools in a very creditable manner.

The chief purpose of the county agricultural schools as now e
lished in Wisconsin is to popularize agricultural education (more
can be done by a well-filled State college). The schools are sub
nate to the State college in that their courses of study are n
advanced (especially in their academic subjects). Students are
mitted directly from the rural schools. Most of them would n
go to an agricultural school if this new class of schools were
brought close to them. Some students board at home and help
home chores; others visit home at the end of each week, and are d
nated with the home spirit throughout their school life. Certa
these county institutions reach a class of pupils that would not
that they could spare the money necessary to attend the State agr
tural college, and yet there are students who, after getting the v
of the county school, will feel like continuing their education and
attend the State college of agriculture. Several graduates are alre
planning such a course. More county schools of agriculture will
fill the State college to overflowing.

# EXHIBITS AT THE LOUISIANA PURCHASE EXPOSITION.

## EXHIBIT OF THE OFFICE OF EXPERIMENT STATIONS.

By WALTER H. EVANS, *Office of Experiment Stations.*

An exhibit was made of the work of this Office in the Government building at the Louisiana Purchase Exposition. On January 6, 1903, Hon. J. H. Brigham, chairman of the Government board and representative of the Department of Agriculture, notified the Director of this Office that $4,000 had been allotted for the preparation, installation, and care of the exhibit of the Office of Experiment Stations in connection with the Department of Agriculture exhibit in the Government building. A few days later the writer was designated as the representative of the Director to have charge of the exhibit. After considerable delay and correspondence, a space embracing about 1,400 square feet was assigned to the Office of Experiment Stations exhibit in the southeast part of the Government building. (Pl. XXXV, fig. 1.) This space, while of sufficient extent, was poorly situated, as it was partly under a balcony, resulting in the poor lighting of part of the space, while another portion was nearly separated from the rest of the exhibit by a large iron truss. This made the exhibit lacking in continuity, but by covering this and another truss it was possible to extend the wall space to nearly double the original assignment, which permitted of the moving of exhibits from the walls under the balcony. The exhibit was planned, after consulting with the various experts in the Office, so as to show the functions of the Office as a Governmental agency for the promotion of agricultural education and research, its relations with the experiment stations organized in the several States and Territories under the act of Congress of March 2, 1887, and also to show the special investigations with which this Office has been charged by the Secretary.

The relation of the Office of Experiment Stations to the Department of Agriculture and to the State experiment stations was shown by a series of charts, which gave the organization, resources, lines of investigation, systems of agricultural education, etc., of the different institutions. The opportunities offered in the United States for agricultural education and scientific research along agricultural lines were also shown by means of charts. All the publications of the

Office of Experiment Stations were shown, and a special exhibit was prepared to indicate the scope of the Experiment Station Record, which is now in its sixteenth volume. The Experiment Station Record is a monthly abstract journal in which the agricultural literature of nearly every land is reviewed. The material abstracted in the first fourteen volumes has been estimated to represent approximately 750,000 pages of original matter. If these original pages were brought together they would make about 700 volumes the size of the Record. In addition the Record contained over 100 leading articles giving the results of research and summaries of knowledge along lines of economic importance to agriculture. This exhibit was shown by a large case containing a set of the Record, with dummy books suitably inscribed representing the leading scientific foreign and domestic journals in all lines relating to agriculture in its broadest interpretation. In another case there were shown the title pages of all publications issued by the Office during the year previous to the exposition. The total number of these title pages was 115. The card index to experiment station literature was shown by a set of cards. This index gives references to and brief abstracts of the experiment station bulletins and reports from 1888 to date, the number of cards now issued being over 25,000, and the index is being increased annually by about 2,000 cards. A set of the bulletins and reports of the different experiment stations to the number of about 600 volumes was shown and was frequently consulted by visitors who were interested in the work of the stations or who desired information regarding specific topics. A map showing the location of the experiment stations in the United States was shown, as were also portraits of the late Senator Justin S. Morrill, through whose efforts the establishment and endowment of the agricultural colleges were secured, and of the Hon. William H. Hatch, who was largely instrumental in securing the legislation providing for the establishment of the agricultural experiment stations in the United States.

As illustrative of some of the special lines of work assigned to this Office, exhibits were made of the investigations of the insular experiment stations in Alaska, Hawaii, and Porto Rico; the nutrition investigations; irrigation and drainage investigations, and farmers' institutes. The exhibits of the insular stations consisted mostly of the agricultural and horticultural products of the countries represented. In a case devoted to Alaska products were shown samples of wheat, oats, rye, and barley from a number of localities. (Pl. XXXVI, fig. 1.) Not only were the stations at Sitka, Kenai, Copper Center, and Rampart represented, but numerous contributions were received from other points, showing the possibility of growing hardy vegetables and cereals over a considerable portion of Alaska. Ripened

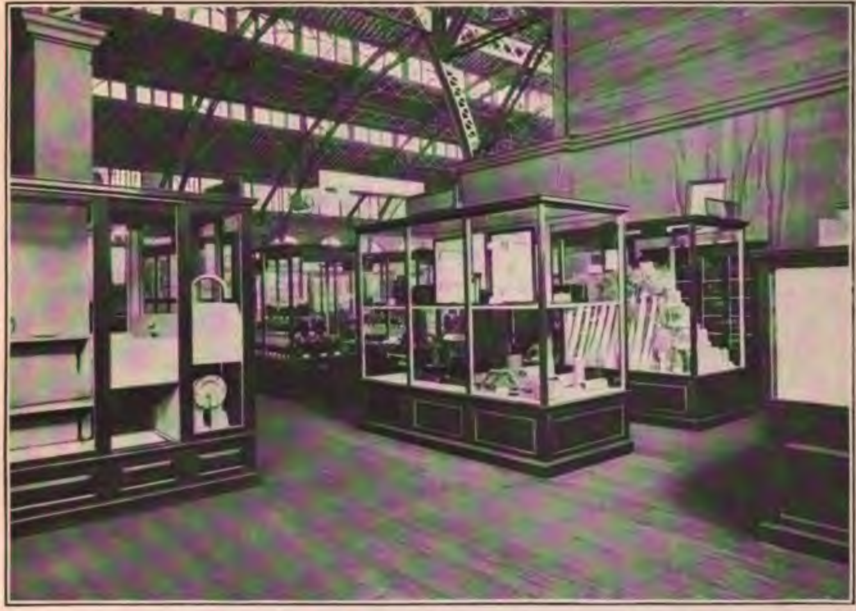

FIG. 1.—GENERAL VIEW OF EXHIBIT AND IRRIGATION AND DRAINAGE CASES.

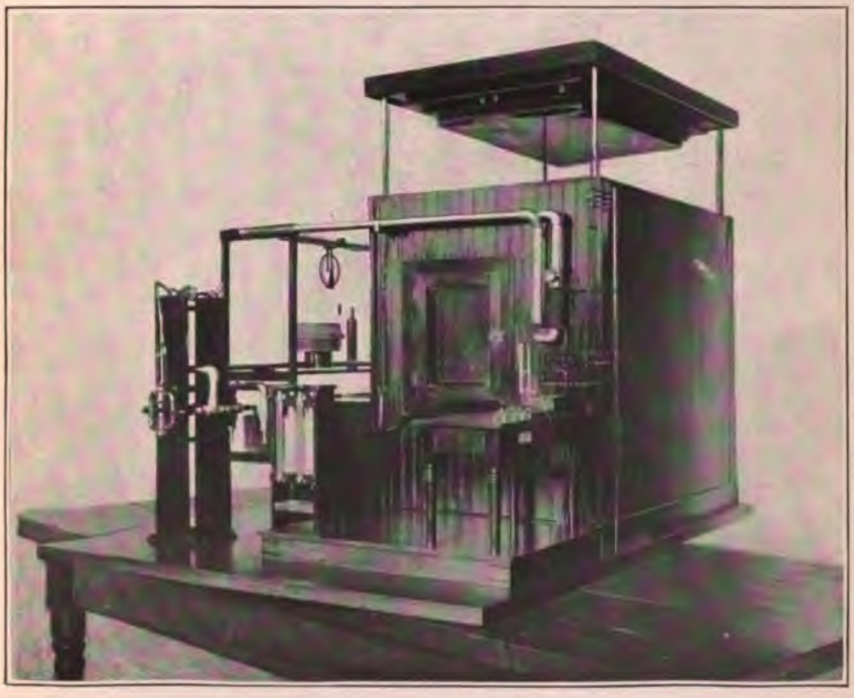

FIG. 2.—MODEL OF RESPIRATION CALORIMETER.

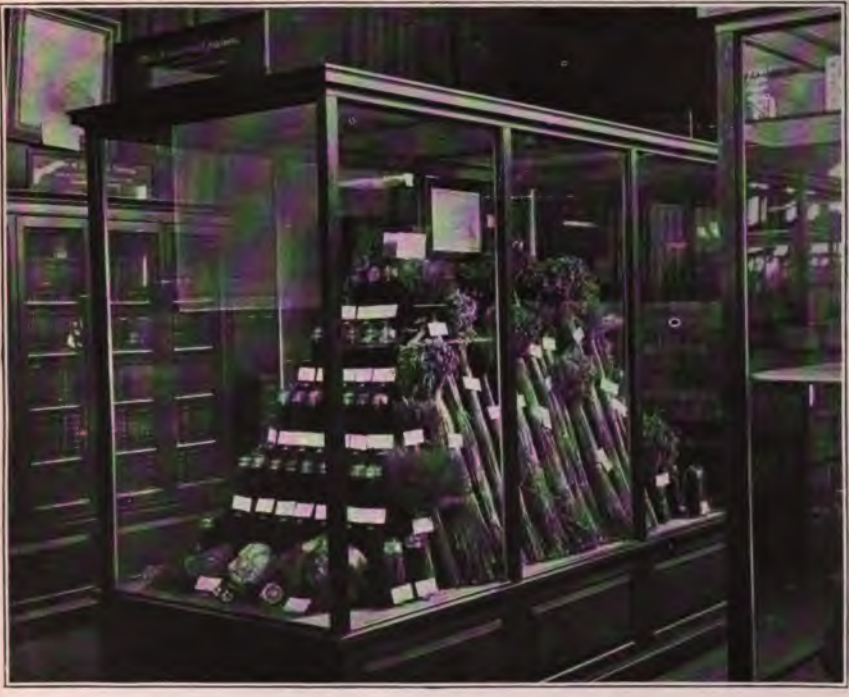

FIG. 1.—ALASKA EXHIBIT.

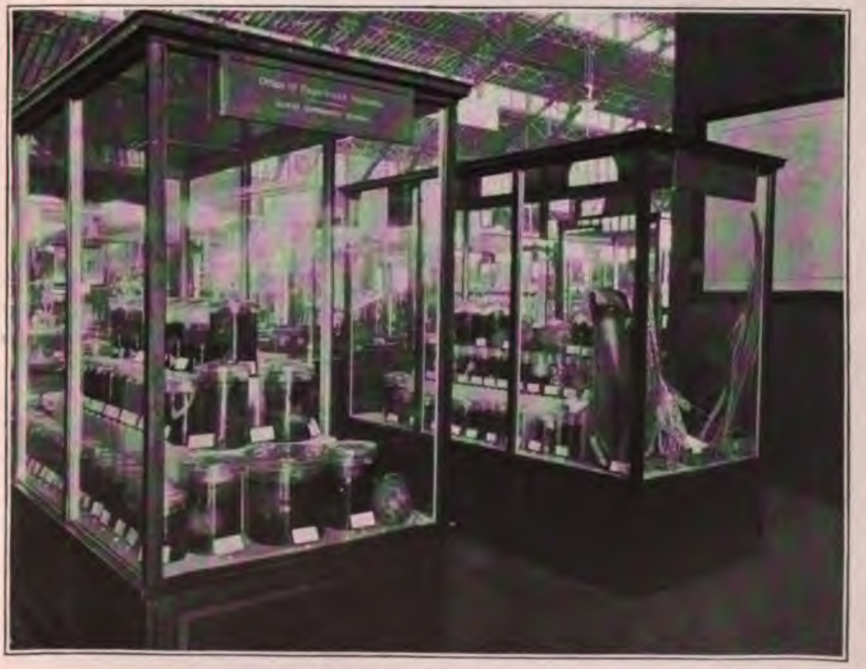

FIG. 2.—HAWAII AND PORTO RICO EXHIBITS.

grain, both in the sheaf and thrashed, was shown from Sitka; Kenai, on Cook Inlet; Copper Center, in the Copper River Valley, 110 miles north from Valdez, and from Rampart on the Yukon, 65° 30′ north latitude. Models of vegetables of large size and of reputed good quality were shown, and a comprehensive exhibit was made of the native and introduced berries of the country. The experiment station was first established at Sitka in 1898, since which time branches have been established at Kenai, Copper Center, and Rampart. These stations, through their investigations and examples, have very materially aided in extending the cultivation of hardy garden produce, and have shown some of the possibilities of grain growing in Alaska. From the Hawaii and the Porto Rico stations were shown extensive collections of tropical products. (Pl. XXXVI, fig. 2.) These embraced many distinct varieties of mangoes, alligator pears, pineapples, oranges, lemons, pomelos, bananas, cocoanuts, etc., as well as specimens of guavas, bread fruit, sour sop, cashew nuts, figs, granadillas, papaya, loquats, etc. The various stages coffee passes through, from the tree to the market, were shown by numerous specimens. Rice, cacao, vanilla, and tobacco, and their methods of preparation, were shown in a similar manner. Samples of fiber were shown, with many native manufactured articles from them. The exhibits from the insular stations proved very attractive and suggested many inquiries relative to the countries in which they were produced, their agricultural possibilities, people, etc.

The investigations in human nutrition, which are conducted under the immediate direction of Prof. W. O. Atwater, Middletown, Conn., were designed to show the methods pursued in studying the uses and economy of foods and some of the results already obtained by these studies. There were shown a model of the modified respiration calorimeter (Pl. XXXV, fig. 2), a bomb calorimeter, and material illustrating some of the investigations. The respiration calorimeter is located at Middletown, Conn. It is an instrument suited for experiments with man, which permits of the measurement of the total income and outgo of matter and energy, the matter being measured in terms of chemical elements, as nitrogen, carbon, oxygen, etc., while the energy is measured in terms of heat. The respiration chamber, which is of copper surrounded by zinc and wooden walls, is of sufficient size for the subject experimented upon to remain in it with comparative comfort for a number of days and is provided with the necessary conveniences for sleeping, eating, etc. The respiratory products are measured and analyzed by drawing a ventilating current through the chamber and passing it through receptacles containing sulphuric acid to remove the water, and soda lime to remove the carbon dioxid. The heat given off by the body is absorbed in a

current of cold water, which passes in pipes through the c
and is measured by noting the volume of water and its inc
temperature. This instrument is used for studying the fund
laws of nutrition, determining the kinds and amounts of
quired by the body, the comparative value of different foods,
studying the problems connected with ventilation, body tem
and related subjects. The large number of experiments
made with this apparatus have shown that it is remarkably
and of great practical value. The bomb calorimeter which w
is an instrument for measuring with great accuracy the heat o
value of food, excretory products, or other materials. The s
to be examined is pressed into a small pellet and ignited by
an electric spark inside the bomb in an atmosphere of oxyge
heat produced by its combustion passes through the walls of t
and is absorbed in a known volume of water in which the bo
The rise in temperature of the water is accurately measured
nishes data for computing the heat value of the weighed a
substance used. By using these two pieces of apparatus it is
to secure data showing the effect of certain rations on man,
losses due to exercise, work, etc. In the use of the respirati
rimeter a man is shut in it for a period of time varying fro
hours to fifteen days, and constant observations are made u
Many interesting and valuable data have thus been secured,
which have been published in the bulletins of this Office.

Among the other material shown in the nutrition exhib
models showing the losses in cooking meat, studies on the dige
and nutritive value of bread, sample rations of the fruitarian
studied in California, and a series of bottles representing t
centage composition of a number of the more common foods,
bread, milk, various kinds of meat, vegetables, etc. In the e
showing the losses in meat due to cooking there were show
models representing meat before and after cooking by roasti
ing, and broiling, and accompanying each was a series of
showing the proportionate amount of the different constitue
The exhibit of flour and bread consisted of 5 pounds of wheat
into three types of flour—graham, whole-wheat, and roller-
flours—with their by-products. Loaves of bread from equal w
of the different kinds of flour were shown, and in bottles were
the proportionate amount of food and other constituents in eac
and their relative digestibility.

As illustrative of the work of irrigation and drainage inv
tions, under the charge of Elwood Mead, exhibits were shown
pavilion cases. One of these was of special construction and
a working exhibit showing the methods of rating currents, m
ing water, evaporation, etc. The case was constructed so as t

tain a centrifugal pump and motor, tanks, weirs, flumes, several kinds of current meters and water registers, an evaporation tank, etc., and it was possible to show all the apparatus in actual use by pumping the water from a large tank in the bottom of the case to a tank above and at one end. From here it escaped through a miner's inch weir, ran through a flume, where the current was measured, and fell again into the lower tank. All the instruments were mechanically arranged to record the various features for which they were devised. In the second case were shown various types of water registers and current meters, their development and improvement, silt samplers, models of irrigation structures, types of flumes, drainage tiles, etc. Charts were exhibited showing some of the results of investigations on the duty of water, amount needed for different crops, the actual amounts applied, etc. Photographs were shown of a number of important irrigation structures, of streams under investigation, and of the results of irrigation in arid regions.

By means of a series of charts the organization and development of farmers' institutes in the United States were shown. An attempt is being made by this Office to organize the work of farmers' institutes and to render whatever aid is possible through the State directors, institute lecturers, and others. The exhibit sought to show this work and its relation to the Department of Agriculture.

On the whole, the Office of Experiment Stations exhibit proved a very attractive one, and in order to fully explain it a demonstrator was kept at the exhibit throughout the whole period of the exposition to answer questions regarding the work of the Office and its relations to the Department and to the several State stations.

# EXHIBIT OF COLLEGES OF AGRICULTURE AND MECHANIC ARTS AND EXPERIMENT STATIONS.

By W. H. Beal,
*Chief of Editorial Division, Office of Experiment Stations.*

## Introduction.

The movement to prepare this exhibit was instituted at the 1901 meeting of the Association of American Agricultural Colleges and Experiment Stations, in Washington, and two committees were appointed to consider the matter, one representing agriculture and the other mechanic arts. At the Atlanta meeting of the association in October, 1902, these committees reported in favor of exhibits. The two committees were consolidated into one as an exposition committee, as follows: W. H. Jordan, director New York State Experiment Station, chairman; A. C. True, Director Office of Experiment Stations, secretary; W. T. Harris, United States Commissioner of Education; H. J. Waters, dean college of agriculture, University of Missouri, and director of Missouri Experiment Station; W. M. Hays, professor of agriculture, University of Minnesota, and agriculturist, Minnesota Experiment Station;[a] W. E. Stone, president Purdue University; T. F. Hunt, professor of agronomy, Cornell University, and agronomist, New York Cornell Experiment Station; C. F. Curtiss, dean division of agriculture, Iowa State College, and director Iowa Experiment Station; J. K. Patterson, president Agricultural and Mechanical College of Kentucky, and H. W. Tyler, professor of mathematics and secretary of faculty, Massachusetts Institute of Technology.

At the same meeting the executive committee of the association was charged with the duty of soliciting from Congress an appropriation for installing and maintaining an exhibit. Congress made such provision in the following terms:

> For the selection, purchase, preparation, transportation, arrangement, installation, safe-keeping, exhibition, and return of such articles, animals, and materials belonging to or used by the agricultural colleges and experiment stations hereinafter referred to, as the Government board created by act of Congress approved March third, nineteen hundred and one, as amended by the act o June twenty-eighth, nineteen hundred and two, may decide to exhibit as a par of the Government exhibit, to show the progress of education and experimentation in agriculture, mechanic arts, and animal husbandry at the Louisian

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[a] Now Assistant Secretary of Agriculture.

Purchase Exposition, to be held under the authority of said act, of the colleges of agriculture and mechanic arts and agricultural experiment stations receiving the benefits of the acts of Congress of July second, eighteen hundred and sixty-two, March second, eighteen hundred and eighty-seven, and August thirtieth, eighteen hundred and ninety, one hundred thousand dollars, to be immediately available, which sum shall be expended for that purpose only and upon the authority of said Government board: *Provided*, That the Louisiana Purchase Exposition Company, at its own cost and expense, shall furnish to said Government board adequate and suitable space in an appropriate building or buildings for the installation of said exhibit and its exhibition during the continuance of said exposition.

The Government board referred to in this act was made up as follows: Hon. J. H. Brigham, Assistant Secretary of Agriculture, chairman;[a] William H. Michael, chief clerk Department of State; Wallace H. Hills, chief clerk Treasury Department; John C. Scofield, chief clerk War Department; Frank Strong, chief clerk Department of Justice;[b] John B. Brownlow, clerk, Post-Office Department;[c] B. F. Peters, chief clerk Navy Department; Edward M. Dawson, chief clerk Department of the Interior; Carroll D. Wright, Commissioner of Labor, Department of Commerce and Labor; F. W. True, head curator National Museum, representing Smithsonian Institution and National Museum; W. de C. Ravenel, administrative assistant National Museum, representing Commission of Fish and Fisheries; G. W. W. Hanger, chief clerk Bureau of Labor; Williams C. Fox, chief clerk Bureau of the American Republics; William V. Cox, secretary, and William M. Geddes, disbursing officer.

This board intrusted the work of planning, collecting, and installing the exhibit to the exposition committee of the association named above, and made the Director of the Office of Experiment Stations, as secretary of the committee, the special representative of the committee in its relations with the board and responsible for the proper expenditure of the funds granted by Congress for the purposes of the exhibit. Mr. James L. Farmer, as chief special agent, had immediate charge of the execution of the plans of the committee.

It should be noted, especially, that the law provided for an exhibit of the progress of education and research in agriculture and the mechanic arts, and it was the purpose of those charged with the duty of preparing the exhibit to make it illustrative of the distinctive work of the land-grant colleges, of which there are 65, and the experiment stations, of which there are 60, in the United States—that is, it was intended to represent those features of education and research which differentiate these institutions from other educatio and scientific institutions. It was concluded that this purpose cou best be accomplished by making the exhibit collective, i. e., assembli the contributions from the various institutions represented accordi to subjects rather than by institutions, due credit, of course, bei given to all contributors to each group. The exhibit was therefo grouped according to the main divisions of agriculture and mechan arts, 51 institutions being represented by contributions of vario kinds.

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[a] After the death of Secretary Brigham, which occurred June 29, 1904, Mr. Hills was made chairman of the board and S. R. Burch, chief clerk Department of Agriculture, was appointed as the representative of that Department on the board.

[b] Succeeded by Cecil Clay, general agent.

[c] Succeeded by Merritt O. Chance, chief clerk.

Since the work of the colleges of agriculture and mechanic ar and the experiment stations is in its broadest sense largely educ tional, it was deemed appropriate that the main exhibit should installed in the Palace of Education. In this way, in the opinion the committee, the work of these institutions would take its rightf place among the great educational efforts of the nation and secu a recognition not otherwise possible.

The exhibit occupied a total area of 16,000 square feet, or, deduc ing aisles, etc., an available space of about 11,500 square feet in t northwest section of this building. (Pl. XXXVII.) A suppl mentary exhibit in stock and grain breeding and judging was pr vided for in an ellipse 40 by 70 feet in size in Live Stock Congr Hall in the agricultural section of the fair grounds.

The individual exhibits and the experts who had charge of th collection and preparation were as follows:

## Classification of Exhibits.

### CENTRAL EXHIBITS OF THE BUREAU OF EDUCATION AND TH OFFICE OF EXPERIMENT STATIONS.

Bureau of Education Exhibit, showing relations of the Unit States Government with education in agriculture and mechanic art under direction of W. T. Harris, United States Commissioner Education.

Office of Experiment Stations Exhibit, illustrating relatio of the United States with institutions for research in agricultur under direction of A. C. True, Director Office of Experiment Station

### AGRICULTURAL EXHIBITS.

Agronomy, or Plant Production, including soils, in charge M. F. Miller, assistant professor of agronomy, Ohio State University fertilizers, E. B. Voorhees, director New Jersey Experiment Station plant laboratory, W. H. Evans, of the Office of Experiment Station field crops, J. I. Schulte, of the Office of Experiment Stations; hort

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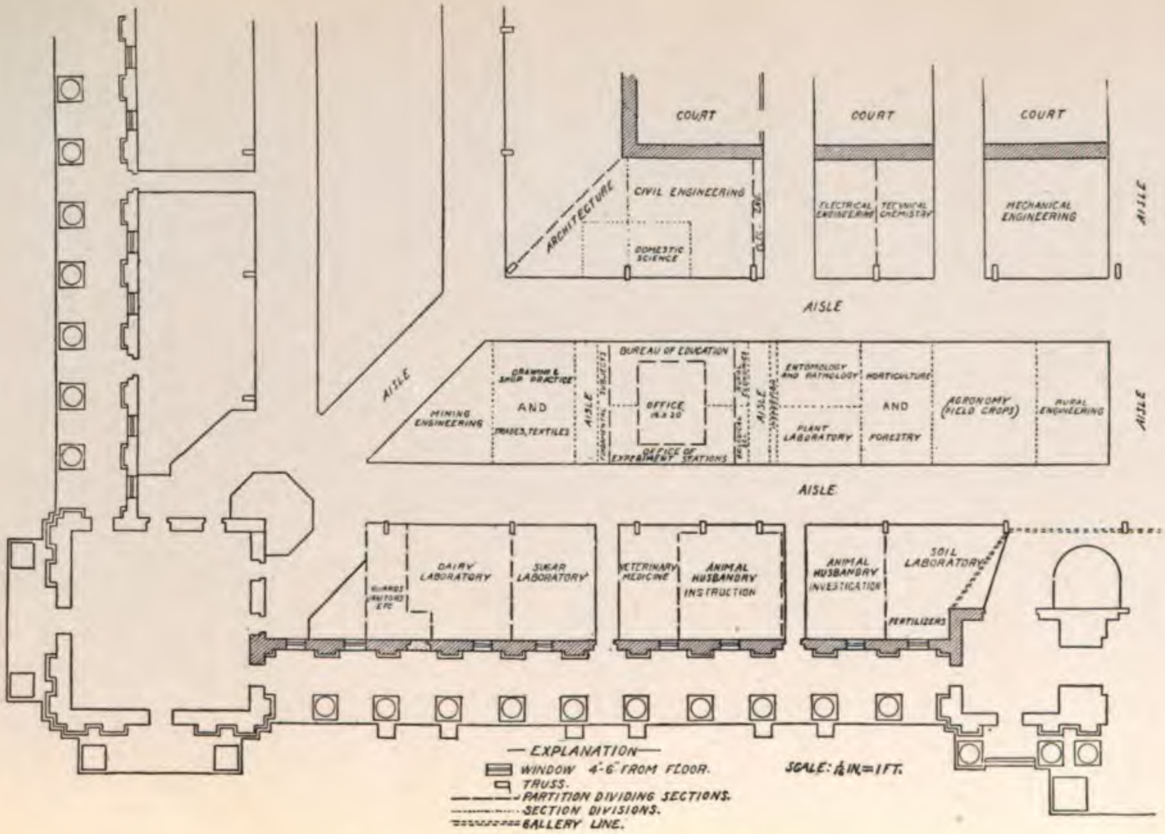
[a] Now professor of agronomy, University of Missouri, and agronomist of t experiment station.



INSTALLATION PLAN, COLLEGE AND STATION EXHIBIT.

culture and forestry, S. B. Green, professor of horticulture and forestry, University of Minnesota, and horticulturist of the experiment station; plant pathology, F. C. Stewart, botanist New York State Experiment Station; economic entomology, C. P. Gillette, professor of zoology and entomology, State Agricultural College of Colorado, and entomologist of the experiment station.

ZOOTECHNY, OR ANIMAL INDUSTRY, including animal husbandry (investigation), in charge of H. P. Armsby, director Pennsylvania Experiment Station; animal husbandry (instruction), T. F. Hunt, professor of agronomy, Cornell University, and agronomist of the experiment station; veterinary medicine, D. S. White, professor of veterinary medicine, Ohio State University.

AGROTECHNY, OR AGRICULTURAL TECHNOLOGY, including dairy laboratory, in charge of E. H. Farrington, professor of dairy husbandry, University of Wisconsin, and dairy husbandman of the experiment station; sugar laboratory, W. C. Stubbs, director Louisiana Experiment Stations; inspection, M. A. Scovell, director Kentucky Experiment Station.

RURAL ENGINEERING, OR FARM MECHANICS. This exhibit was prepared under the direction of Elwood Mead, chief of irrigation and drainage investigations, Office of Experiment Stations.

RURAL ECONOMICS, OR FARM MANAGEMENT. This exhibit was prepared under the direction of F. W. Card, professor of horticulture and agriculture, Rhode Island College of Agriculture and Mechanic Arts, and horticulturist of the experiment station.

## MECHANIC ARTS EXHIBITS.

CIVIL ENGINEERING, in charge of Anson Marston, professor of civil engineering, Iowa State College of Agriculture and Mechanic Arts.

MECHANICAL ENGINEERING, in charge of W. F. M. Goss, professor of mechanical engineering, Purdue University.

ELECTRICAL ENGINEERING, in charge of B. V. Swenson, assistant professor of electrical engineering, University of Wisconsin.

MINING ENGINEERING, in charge of S. B. Christy, professor of mining and metallurgy and dean of the faculty of the college of mining, University of California.

TECHNICAL CHEMISTRY, in charge of W. H. Walker, associate professor of industrial chemistry, Massachusetts Institute of Technology.

ARCHITECTURE, in charge of W. H. Lawrence, associate professor of architecture, Massachusetts Institute of Technology.

DRAWING AND SHOP PRACTICE (INCLUDING TEXTILES AND TRADES), in charge of Prof. F. Paul Anderson, professor of mechanical engineering, Agricultural and Mechanical College of Kentucky.

DOMESTIC SCIENCE, in charge of Maude Gilchrist, dean of women's department, Michigan State Agricultural College.

## SUPPLEMENTARY EXHIBITS.

Stock and Grain Breeding and Judging. This exhibit was co
ducted as a normal school of instruction in Live Stock Congress Ha
under the direction of a subcommittee of the exposition committee
the association consisting of C. F. Curtiss, H. J. Waters, and W.
Hays, J. H. Shepperd, professor of agriculture, North Dakota Agr
cultural College, and agriculturist of the experiment station, bei
dean of the school.

## Description of Exhibits.

### EXHIBIT OF THE BUREAU OF EDUCATION.

(See Pl. XXXVIII, fig. 1.)

Centrally located in the exhibit space was a pavilion and offi
around which were grouped the exhibits of the Bureau of Educatio
and the Office of Experiment Stations, which represent the Unite
States Government in its relations with the land-grant colleges a
experiment stations.

The contribution of the Bureau of Education included a set of t
publications issued by that Bureau, a set of the catalogues of all
the colleges of agriculture and mechanic arts, various publicatio
and illustrations furnished by these institutions, and statistical char

The publications of the Bureau were selected with a view to sho
ing in a measure the work being done by it. The reports of the Co
missioner, which are published annually, contain statistical and g
eral information concerning educational systems and institutions
this and foreign countries, including the colleges of agriculture a
mechanic arts endowed by the National Government. Histori
sketches of some of these colleges are included in the histories
higher education in the several States which have been published
the Bureau as circulars of information.

The set of catalogues showed in detail the nature and scope of t
instruction offered by the several institutions, the material equi
ment available for instruction purposes, the number of profess
and instructors employed and of students in attendance.

The extent of Federal aid to June 30, 1904, in land and mon
granted to each State and Territory for the colleges of agricultu
and mechanic arts established under the Morrill Act of July 2, 18
was shown in a large statistical chart. This showed (1) the amou
of invested funds derived from the sale of the lands granted to ea
State and Territory specifically for colleges of agriculture and m
chanic arts, including the estimated value of unsold land, if an
as reported to the Bureau; and (2) the aggregate amount

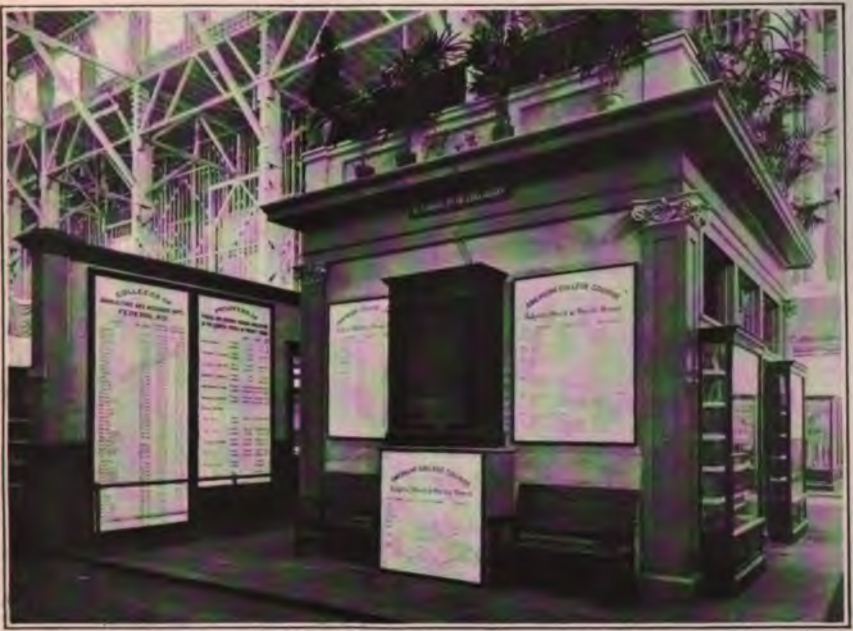


FIG. 1.—EXHIBIT OF UNITED STATES BUREAU OF EDUCATION.

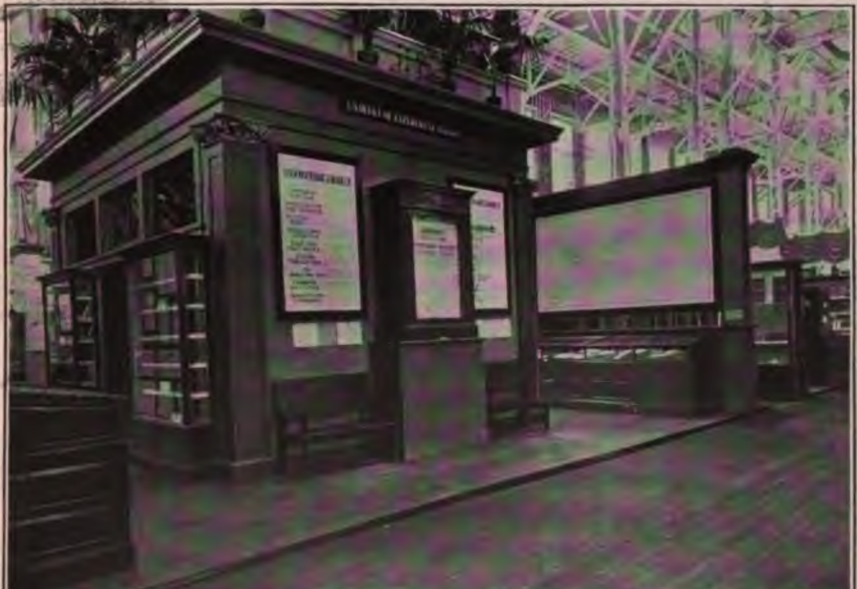


FIG. 2.—EXHIBIT OF OFFICE OF EXPERIMENT STATIONS.

appropriations received by each State and Territory to June 30, 1904, under the act of Congress of August 30, 1890, for the more complete endowment and support of the colleges established under the act of July 2, 1862; and (3) the total amount, $31,157,588, of Federal aid received from the two sources mentioned.

A large map showed the location of each college of agriculture and mechanic arts, the amount of land received by each State for such institutions, and the total amount of land granted by the Federal Government for all other educational purposes.

A large chart, entitled "Progress of Public and Private Higher Education in the United States in Twenty Years," showed, in comparative form, the progress made from 1882 to 1902, first, by the public (including colleges of agriculture and mechanic arts) and, secondly, by the private institutions for higher education.

Smaller statistical charts showed (1) growth in number of students from 1891 to 1903; (2) increase in the value of the material equipment from 1870 to 1903; (3) value of all property, including endowment funds owned in 1903; (4) increase from 1865 to 1903 in the number of institutions, number of professors, and number of collegiate and graduate students; (5) comparison of income from 1885 to 1903 with that of all other institutions for higher education; (6) proportion of regular technical students pursuing certain degree courses; (7) growth of libraries compared with that of all other institutions for higher education; (8) attendance from 1890 to 1903 compared with that at all other institutions for higher education.

There were also shown volumes of examination questions and answers by students of a number of the colleges of agriculture and mechanic arts in English, French, German, Latin, mathematics, physics, chemistry, history, and economics, and in miscellaneous branches. These volumes were intended to give some idea of the nature of the work that is being done by the several institutions in some of the nontechnical or general studies usually included in the courses of study offered by these institutions.

An electrical display machine, showing important facts relating to the history, work, and present status of the colleges of agriculture and mechanic arts, was a prominent and effective feature of this exhibit.

## EXHIBIT OF THE OFFICE OF EXPERIMENT STATIONS.

(See Pl. XXXVIII, fig. 2.)

On the side of the pavilion occupied by the exhibit of the Office of Experiment Stations the central wall space was occupied by an electrical display machine showing prominent features in the origin, distribution, and work of agricultural experiment stations throughout

the world. The location of about 700 of these stations was sho
a map of the world, and charts were displayed showing the va
investigations made by the stations from an educational as w
economic point of view. In bookcases were shown bound se
publications of the Office and of the experiment stations and
200 text-books, manuals, and reference books written or edit
experiment station men. These books are based on the resu
agricultural investigations in this country and abroad and are
very valuable service in reducing these results to pedagogic
They constitute largely the science of agriculture as it is now c
to be recognized in this country. Specimens of the large numb
special publications—circulars, press bulletins, popular bull
spray calendars, etc.—issued by the experiment stations were s
in glass-covered cases.

In wing frames were shown a large number of photographs
trating some of the buildings, live stock, and other equipment o
experiment stations, as well as some of the more striking experi
conducted by them.

Associated with the exhibits of the Bureau of Education an
Office of Experiment Stations was a small exhibit of charts,
ings, photographs, etc., illustrating courses of study, appa
methods, and results of the work of some of the institutions i
logical sciences (botany, zoology, and physiology).

## AGRICULTURAL EXHIBITS.

### I. AGRONOMY, OR PLANT PRODUCTION.

The exhibits illustrating work in this subject included (1)
laboratory, (2) soils laboratory, (3) fertilizers, (4) field crops
horticulture and forestry, (6) plant pathology, and (7) entomo
as well as the supplementary outside exhibits of grain judging
plant breeding (see p. 708.)

#### PLANT LABORATORY.

(Pl. XXXIX, fig. 1.)

The object of this exhibit was to show in operation a fairly
equipped laboratory for instruction and research in the stud
botany in its various phases, but especially as related to agricul
The exhibit illustrated some of the methods followed at the ins
tions contributing to the exhibit, and showed a number of appli
and pieces of apparatus which have been devised or modified by
lege or station men. It contained apparatus for preparing mat
and making microscopic studies of plant tissues; for studying t
spiration and the humidity of the air, and the effect of gravity
plant growth; for recording the rate of growth of plants; for st

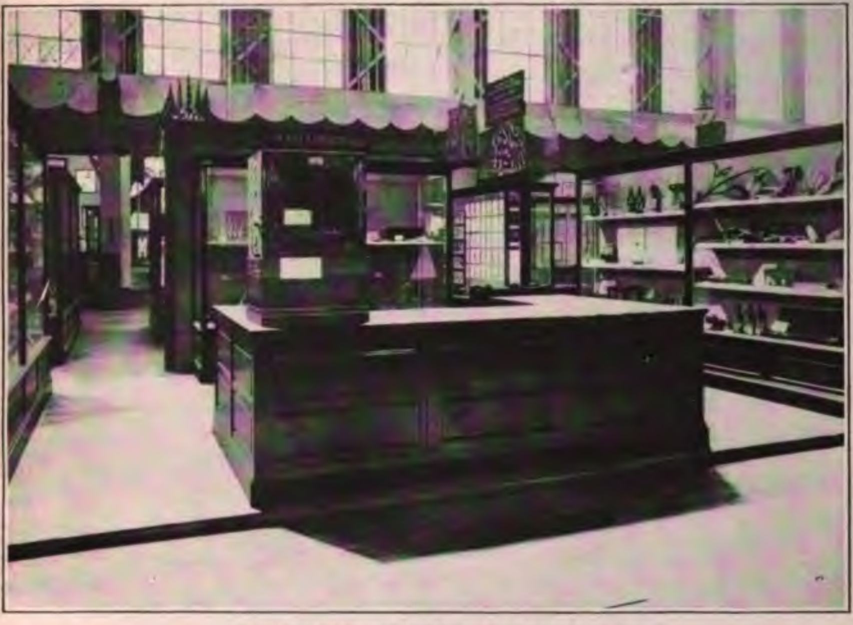


FIG. 1.—AGRONOMY—PLANT LABORATORY.

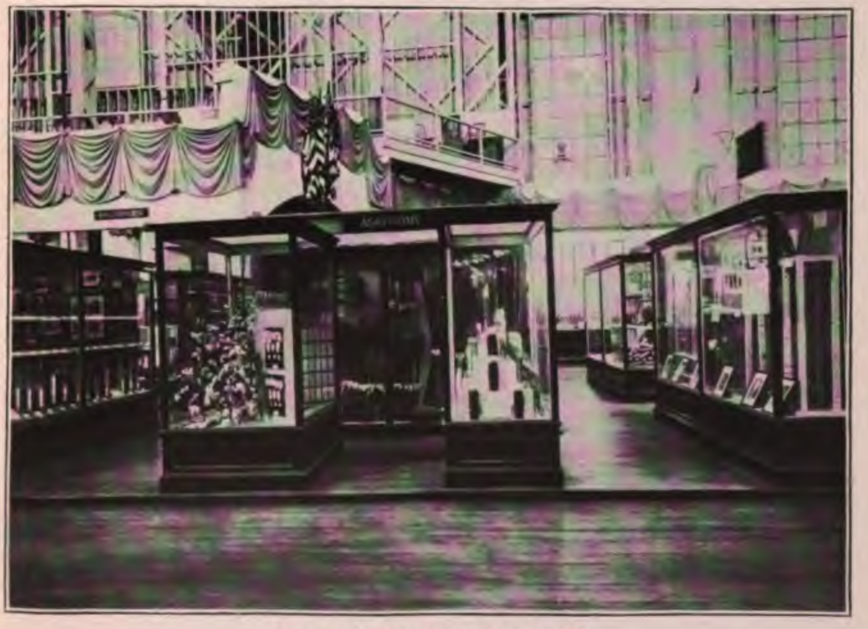


FIG. 2.—AGRONOMY—FIELD CROPS.

of micro-organisms, including ferments and fungus and other parasitic diseases of plants, of root growth, and of germination; for the examination and testing of seeds and for showing the effect of copper on foliage; besides illustrations of methods of making cultures of micro-organisms; of selecting seeds by specific gravity; plant presses; seed cases for class-room use, and miscellaneous laboratory apparatus and accessories.

### SOILS LABORATORY.

This was a working laboratory in operation, equipped with special forms of apparatus contributed by a number of institutions for sampling soils, making mechanical and chemical analyses of soils, and studying their chemical and physical properties; samples of typical soils, student's laboratory outfit, cultures, etc., showing work on soil bacteria; specimens of students' notes and exercises. There were also photographs showing equipment and methods of work in soils at a number of the agricultural colleges and experiment stations.

### FERTILIZERS.

The fertilizer exhibit included (1) specimens of typical classes of soils showing the relative proportion of fertilizing constituents in each, and the relation of these to soil fertility and soil exhaustion; (2) samples of the principal commercial fertilizing materials, including crude and manufactured products, supplying nitrogen, phosphoric acid, and potash; and (3) a series of diagrams and photographs illustrating the relation of various systems of cropping, farm management, and fertilizing to soil fertility, and the relative availability of different kinds of fertilizers.

### FIELD CROPS.

(Pl. XXXIX, fig. 2.)

The object of this exhibit was to show the purposes, methods, and results of investigations on field crops by the experiment stations, together with the methods and scope of instruction given in this particular branch in the colleges of agriculture. It consisted of material illustrating some of the more important experimental work carried on by the experiment stations and the methods employed by the agricultural colleges to prepare the student for original research work and for practical farm management. The various classes of crops were represented and the exhibit of each individual crop was as extensive as circumstances would allow.

One of the principal features of the section was the exhibit of the plant-breeding work. This included selection and crossing of corn to increase yield and the percentage of protein and of oil; samples of wheat illustrating Mendel's law in wheat breeding, the improv ment in yield by selection and crossing, and the methods of growi pedigreed wheat plants and keeping plant nursery records; spe mens of flax showing how by these same methods the seed producti of the crop may be improved and how the straw may be increased length, thus rendering the crop of greater value for fiber; and sa ples of cotton showing the effect on the length and quality of t fiber of crossing varieties of different types, such as the Sea Islan Upland, and Egyptian cottons. The possibilities of plant breedin were further exemplified in the cowpea exhibit, which called atte tion to the extensive variation to which this plant is subject.

Independent of the plant-breeding work, samples of varieties corn, wheat, oats, barley, and other cereals, and of cotton, cowpea soy beans, velvet beans, castor beans, sugar cane, tobacco, hemp, fla and hops were presented for comparison. The yields in some cas show marked differences, pointing out the value of variety testing the experiment stations and the importance of considering this matt in ordinary farm practice.

The exhibit further illustrated the results of growing field cro (wheat, oats, corn, potatoes, clover, and timothy) with different fe tilizers and under various systems of rotation to maintain and i crease the fertility of the soil.

An interesting object lesson was presented in a collection of ro samples showing the root development of bluegrass, corn, oats, clove alfalfa, fife, and macaroni wheats, and flax.

The tobacco exhibit comprised a model illustrating the growing tobacco under shade, a number of samples of shade-grown and ope field-grown tobacco showing the effect of shade on the quality of t leaf, and a series of other samples representing the different types tobacco which have been experimented with in Connecticut.

The apparatus and appliances used in college laboratory work wi root crops, including sugar beets, mangels, ruta-bagas, carrots, a turnips, were shown, and a general outline of the work was given.

The experimental work with field crops carried on at the Alask Hawaii, and Porto Rico stations was represented by a collection specimens from these stations.

### HORTICULTURE AND FORESTRY.

This exhibit consisted of a collection of models, photograph charts, etc., illustrating methods of instruction and research in the subjects at a number of the agricultural colleges and experime stations, as well as special forms of laboratory and greenhouse equi ment and results of improvement of varieties and methods of cultur Improved horticultural and forestry implements and methods we also illustrated, and a collection of horticultural books, edited or written by college and station men, was shown.

Features of special interest were (1) a date-palm exhibit, representing the successful introduction of a new industry into the United States, and showing the fine quality of dates now being grown in Arizona, as well as the peculiarities of date trees, blossoms, fruit, and seed; (2) an exhibit of methods of greenhouse laboratory work as shown by a portion of a greenhouse laboratory bench with lockers, illustrations of horticultural laboratory operations, text-book used, etc.; (3) models of peach twigs, showing the relation of color to hardiness and date of blooming; (4) models, photographs, and charts illustrating a successful method of winter forcing of asparagus; (5) models illustrating fertilization of self-sterile grapes; (6) models illustrating subirrigation for greenhouses, gardens, and lawns; (7) display of implements and methods of pruning; (8) exhibit of trunks of eucalyptus trees illustrating the successful introduction into this country of a group of valuable trees; (9) specimens showing the character of posts and timber produced in regions of deficent rainfall, and (10) log scales, rules, calipers, and other implements used in forestry work and lumbering in different parts of the United States.

There were also wing-frame cabinets containing mounted photographs, charts, drawings, etc., showing facilities and equipment for instruction and research in a large number of the land-grant colleges and experiment stations, horticultural and forestry methods, operations, and results.

### PLANT PATHOLOGY.

This exhibit consisted mainly of mounted specimens, specimens in solutions, photographs, drawings, etc., accompanied by explanatory labels, illustrating the more important diseases of crops and the nature of the injuries caused by them.

### ENTOMOLOGY.

This exhibit consisted of small contributions from a large number of institutions, and was intended to show something of the scope and quality of entomological work being carried on in the different agricultural colleges and experiment stations in the United States. Thirty-two cases of insects showed many of the most destructive as well as some of the beneficial species, and gave an idea of methods of mounting, labeling, and permanently preserving specimens in different stages of development. Pavilion and wall cases were filled with pieces of apparatus used in class room or laboratory or in field work in entomology. There were shown the Sanderson method of note and record keeping, the Comstock block system of mounting a collection of insects, as well as a set of reference books in entomo for students' use, specimens of injuries by boring insects, a sp form of breeding cage, and a new method of fighting the cod moth, etc.

A large number of photographs were displayed, showing buildi laboratories, class rooms, equipment for college and station w methods of carrying on work, spraying machinery, insects and t injuries, diagrams, etc.

## II. ZOOTECHNY, OR ANIMAL INDUSTRY.

### ANIMAL HUSBANDRY—INVESTIGATION.

(Pl. XL, fig. 1)

A complete showing of experiment station work in this field not attempted, but emphasis was laid upon those methods and re which tend to establish fundamental scientific principles rather t upon those yielding more immediately practical results, altho the latter were by no means excluded.

The exhibit was grouped in a general way under three heads, (1) feeding stuffs, (2) metabolism and the laws of nutrition, (3) the practice of feeding.

*Feeding stuffs.*—In this group were shown several forms of ap ratus used in the analysis of feeding stuffs, especially for the dete nation of protein and ether extract (crude fat); an apparatus for ing in vacuo; appliance for making digestion experiments with mals; a complete collection of products and by-products of corn cotton seed; a collection of pure vegetable proteids arranged accor to the classes of feeding stuffs from which they were derived, descriptive data; specimens and charts showing results of inv gations of pentosans of hay, cornstalks, etc.; drawings of microsc studies of the structure of feeding stuffs as a basis for the detec of adulteration. Large wall charts showed the average composi of a few of the more important feeding stuffs; smaller charts sho the average results of digestion experiments with American fee stuffs, the feeding value of corn silage and corn by-products, similar data.

*Metabolism and the laws of nutrition.*—A working model, one-f the actual size, of the respiration calorimeter constructed by the Pe sylvania Station cooperating with the Bureau of Animal Indu of the U. S. Department of Agriculture for experiments with la farm animals, and modeled after the Atwater-Rosa apparatus, shown. The purpose of this apparatus is to determine, in additi to those facts which can be ascertained by an experiment with digestion apparatus, the amount of gaseous material (carbon dio

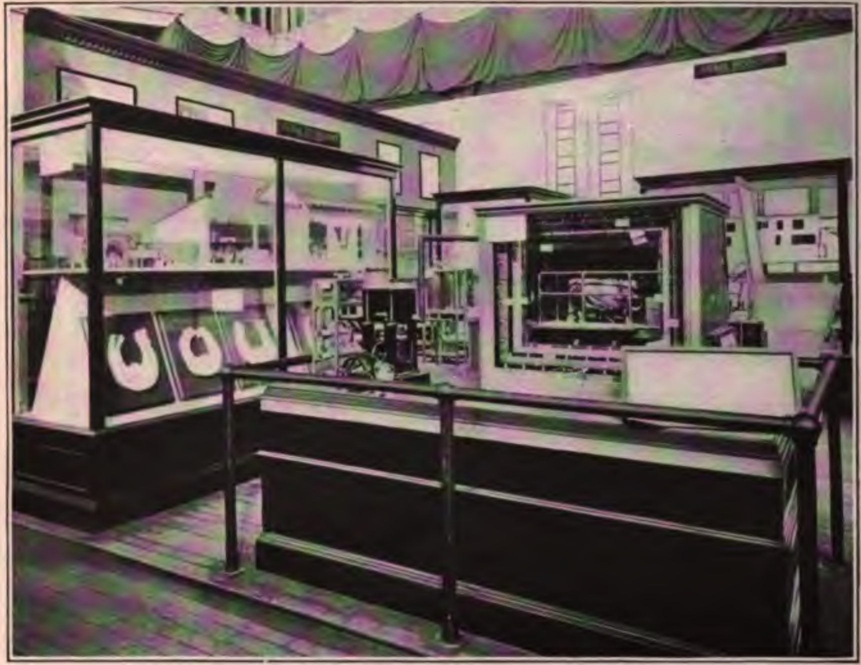


FIG. 1.—ANIMAL HUSBANDRY—INVESTIGATION.

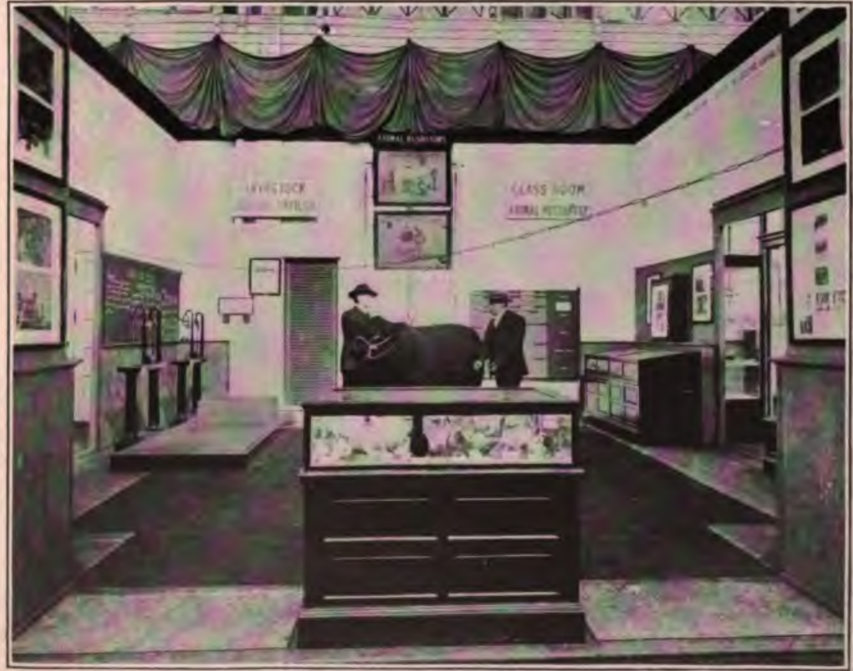


FIG. 2.—ANIMAL HUSBANDRY—INSTRUCTION.

water, methane) given off by the animal, and also the amount of energy liberated by it in the form of heat, a complete account being kept of the outgo of both matter and energy from the animal, in order to show exactly how much of its food is utilized and for what purpose.

The results of a series of four experiments with this apparatus upon timothy hay were illustrated in the exhibit, the quantities of energy involved being represented by blocks of anthracite coal sufficient to produce equivalent amounts of heat when completely burned. The exhibit showed (1) total energy of the food, (2) amount lost in the various excreta, (3) amount of food energy supplied by oxidation of the tissues of the body when there was a loss in weight, or the part of the energy of the food which was stored as increase of tissue when there was a gain in body weight. Charts showing graphically some of the results of these experiments were also shown.

There was also an exhibit of the total energy of 10 kilograms of timothy hay and of corn meal, respectively, and the portion of this lost in the excreta, consumed by the processes of digestion and assimilation, and remaining available for the general purposes of the organism.

In the exhibit of the results of experiments upon the sources of milk fat there was shown in glass cylinders the amount of fat digested from the food of each of three cows, the fat that may possibly have been formed from the protein broken down in the body, the fat actually found in the milk, and the fat which must necessarily have been produced from the carbohydrates of the food. The same results were shown graphically in a series of seven charts contained in wall cabinets.

*The practice of feeding.*—The influence of shelter and of concentrated feeds rich in nitrogen on growth of beef cattle, the comparative value of different kinds of roughage, and the influence of food on the make-up of the carcass were shown by means of models and charts.

The results of experiments on soiling crops, with views of modern dairy buildings and equipment, were shown by means of transparencies.

There were also shown trap nests used in breeding experiments with poultry, and illustrations of methods of preserving eggs in water glass.

Practical and theoretical methods of feeding horses were illustrated by sample rations and chart data.

### ANIMAL HUSBANDRY—INSTRUCTION

(Pl. XL, fig. 2.)

This exhibit illustrated a class room for instruction in this subject, including a mount of Shamrock, the prize-winning steer of the Chicago live-stock show of 1902; the most improved implements, apparatus, and accessories required for instruction; wall charts, sh ing enlarged specimens of students' score cards, and a series mounted photographs illustrating methods of instruction in subject at a large number of agricultural colleges. (See also acc of supplementary exhibits, p. 708.)

### VETERINARY MEDICINE.

This exhibit contained a large amount of material illustrat methods and appliances used in instruction and research in this ject, with specimens of animal diseases.

## III. AGROTECHNY, OR AGRICULTURAL TECHNOLOGY.

### DAIRY LABORATORY.

(Pl. XLI, fig. 1.)

The attempt was made in this exhibit to illustrate, by mean objects, apparatus, charts, large photographs, and descriptive r ter, the dairy instruction given in the American agricultural coll and some of the results of dairy investigations made in the exp ment stations. It showed the quality of dairy products made different methods and under different conditions, and the meth machinery, and appliances used in testing and handling milk its products.

Special features were exhibits illustrating the composition of d products of various kinds, the machinery, appliances, and meth used in the testing of milk, butter, and cheese; cultures of the v ous bacteria which bring about changes in milk and dairy produ methods of obtaining clean milk and of making and preserv butter and cheese; methods of handling and skimming milk; co tions affecting milk production, and dairy buildings and equipm of various agricultural colleges and experiment stations of the Un States.

### SUGAR LABORATORY.

(Pl. XLI, fig. 2.)

*Sugar cane and its products.*—This exhibit was divided into principal groups. The first consisted of a large collection of su cane varieties, grades of commercial sugars, sirups and molasses, tilizers, and other products relating to the agricultural and techn sides of the sugar-cane industry. The second showed the dif ent apparatus and appliances employed. A number of photogra charts, and diagrams were also exhibited.

Sixty-four of the different natural varieties of sugar cane p duced at Audubon Park from canes obtained from the West Ind Mexico, Hawaii, Java, India, and other parts of the world w

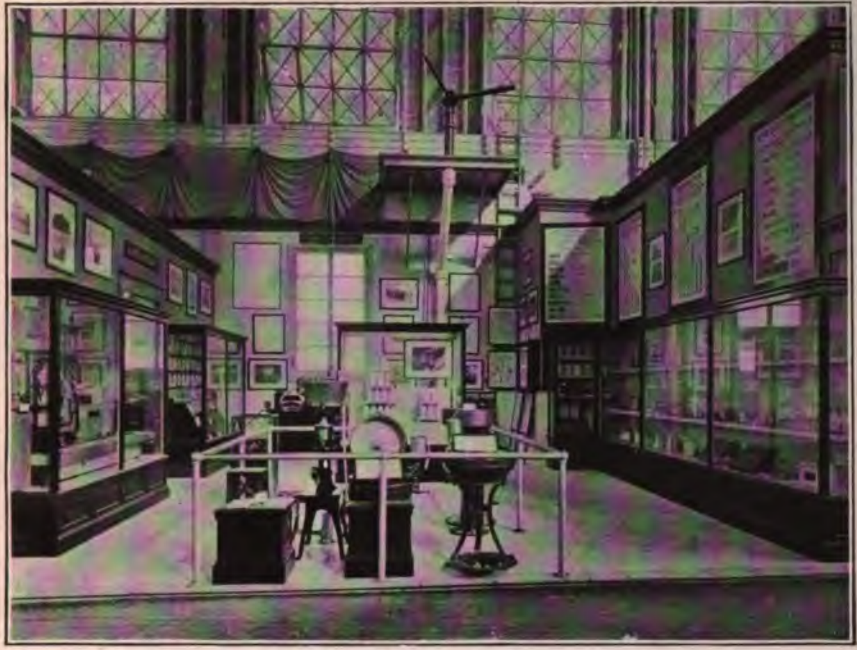


FIG. 1.—DAIRY LABORATORY.

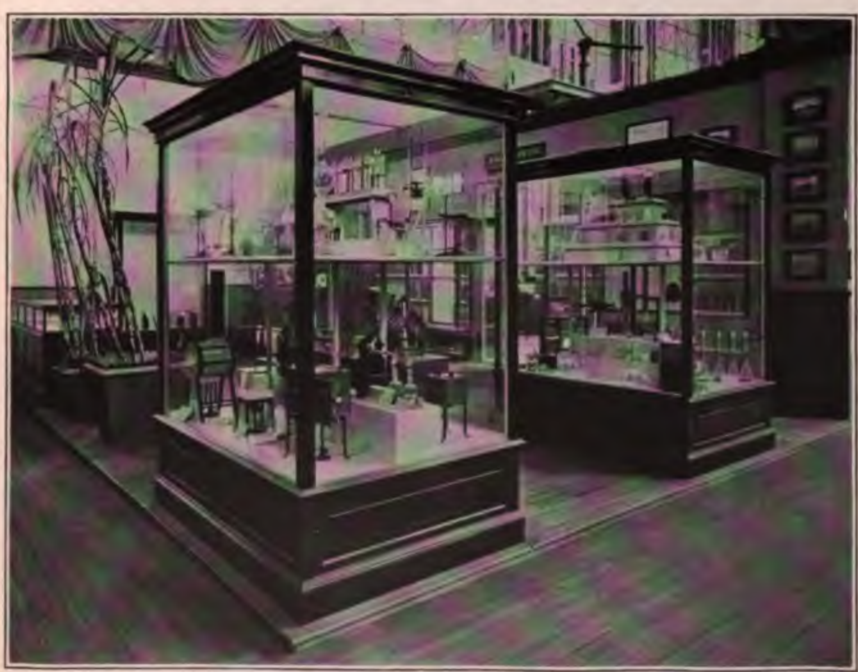
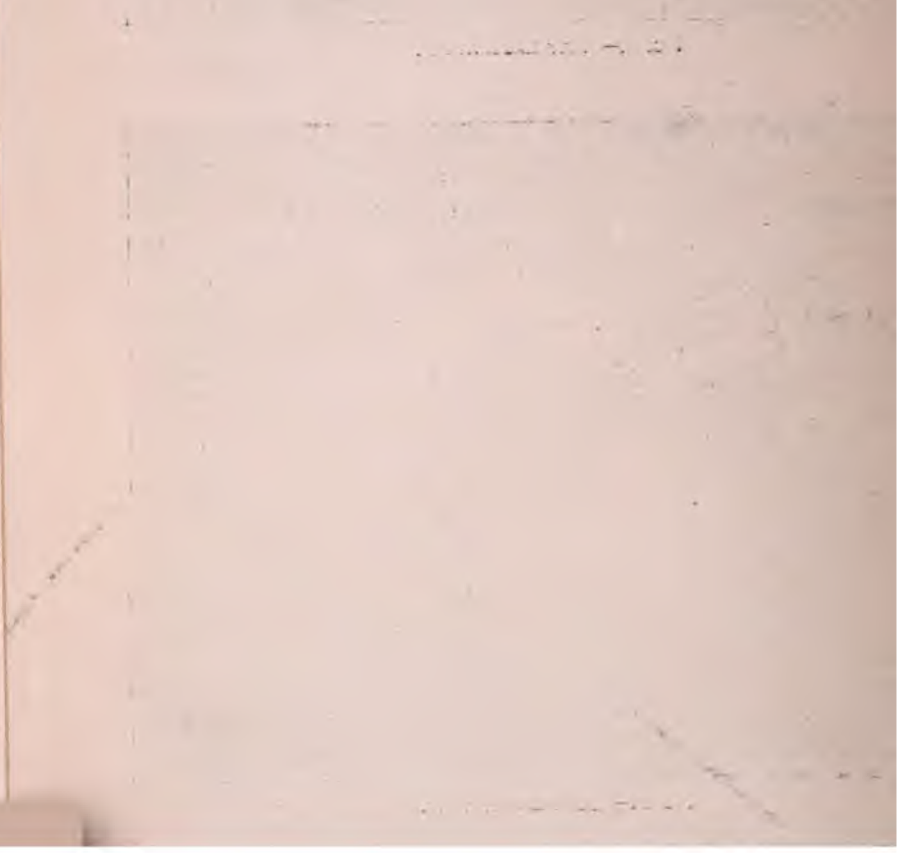


FIG. 2.—SUGAR LABORATORY.



shown. Among these were the Louisiana Purple and the Striped varieties, which are the chief canes cultivated in Louisiana, and the Creole variety, which was the first cane introduced into Louisiana, having been brought in by the Jesuits in 1757. The sugar cane is an exotic in Louisiana, and does not flower nor produce seed. In the tropical countries, however, seed is produced, and a specimen of this was shown. A great deal of attention has been paid of late to the propagation of new varieties of cane from sugar-cane seed, and many of these seedling varieties have been studied. Nineteen specimens of these were shown in jars. Of particular importance in Louisiana are the seedlings D. 74 and D. 95 (Demerara Nos. 74 and 95). These canes, particularly the D. 74, give a larger tonnage than the home varieties, and also a much greater sugar content.

Specimens of the various fertilizers employed in experiments with sugar cane were shown in the exhibit, and the results of fertilizer and cultivation experiments were presented by charts.

Products from the sugarhouse were shown illustrating all the stages in the manufacture of sugar from the raw juice through the processes of clarification, evaporation, and crystallization to the final product or "first sugar," the molasses from which when separated by centrifugals yields second and third sugars. Details of the sugarhouse work were illustrated by charts.

Samples of the different grades of commercial sugars and of the various grades of sirups and molasses which are manufactured upon the plantations of Louisiana were also shown, as well as specimens of the different refined sugars manufactured from the raw plantation products.

A large amount of molasses is being fed in Louisiana to farm animals, either in the liquid state or mixed with absorptive ingredients, such as hay, bagasse, rice, bran, corn, oats, etc. The manufacture of these mixed feeds is an industry of growing importance, and a number of the most common commercial mixtures were shown in the exhibit. Large quantities of molasses are also fermented and worked up into alcohol and different grades of distilled products. Samples of the latter were exhibited. Molasses, after the alcoholic fermentation, is also made up into vinegar, a sample of which was shown in the exhibit.

The mill bagasse, or expressed cane, is at present utilized almost entirely as a fuel under the sugarhouse boilers. Experiments have been made toward a better utilization of bagasse for the manufacture of paper. Samples of bagasse, pulp, and different grades of paper were shown. Some of the papers, particularly those made from the pithy part of the bagasse, possess parchment-like properties that render them exceedingly valuable. Specimens of fiber board manufactured from bagasse were also shown. This fiber board has exceedingly valuable properties, which render it useful for the manufacture of powder casks, veneerings, panels, and a number of other products.

There was shown a laboratory exhibit containing a collection of the common sugars and carbohydrates from various sources, together with various products and derivatives of the same, and of laboratory appliances and apparatus used in sugarhouse control and more technical studies in sugar chemistry. Apparatus for the determination of the melting point of the hydrazones and osazones, which is of great value in the study and identification of the different sugars, was also shown in the exhibit.

*Sorghum and its products.*—This group contained samples of sorghum canes and sorghum sirup, sugar, molasses, and masse cuite, and illustrated the possibilities of this crop for sugar production.

*Maple sugar.*—This group illustrated old and modern methods and appliances used in collecting sap and preparing maple sugar and sirup, as well as the results of investigations on the flow of sap carried on by the Vermont Station for a number of years.

### INSPECTION, OR CONTROL WORK.

This exhibit illustrated by means of samples, charts, etc., the work of the agricultural colleges and experiment stations in the inspection of fertilizers, feeding stuffs, etc. About thirty States provide by law for inspection of some kind, and in the large majority of cases the work is done by the agricultural experiment stations of the various States and Territories.

## IV. RURAL ENGINEERING, OR FARM MECHANICS.

(Pl. XLII, fig. 1.)

This exhibit consisted of apparatus, models, charts, photographs, etc., illustrating methods of irrigation and drainage (including models of a plant house and farm plats used for investigations in these subjects), farm buildings and implements (including homemade windmills, silos, plows, etc.), the lay out of farms (students' plans, etc.), courses of instruction, etc., at the land-grant colleges and experiment stations.

## V. RURAL ECONOMICS, OR FARM MANAGEMENT.

This exhibit consisted almost exclusively of charts showing actual and proposed courses of instruction in the land-grant colleges and statistics relating to different systems of farm management.

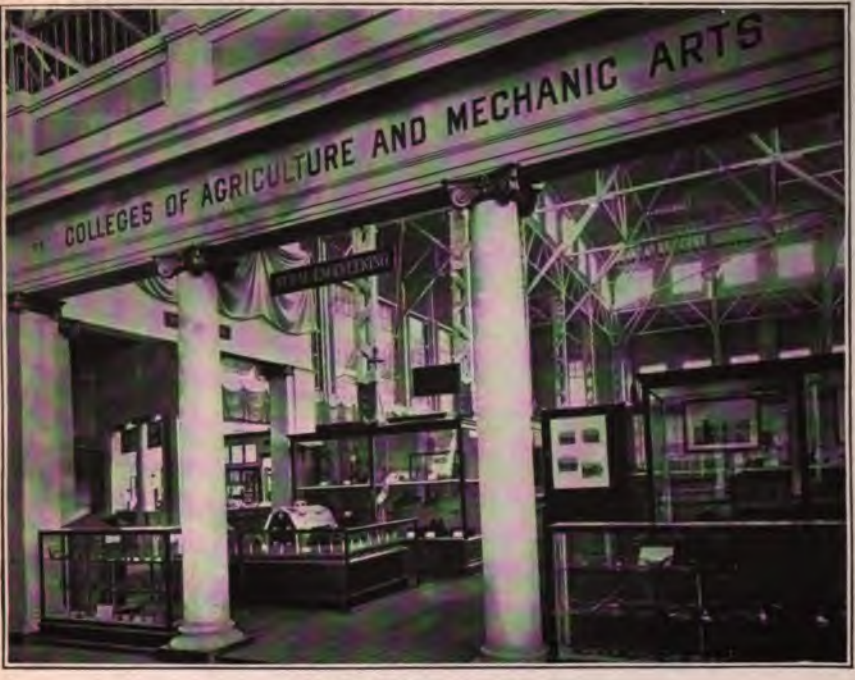


FIG. 1.—RURAL ENGINEERING.

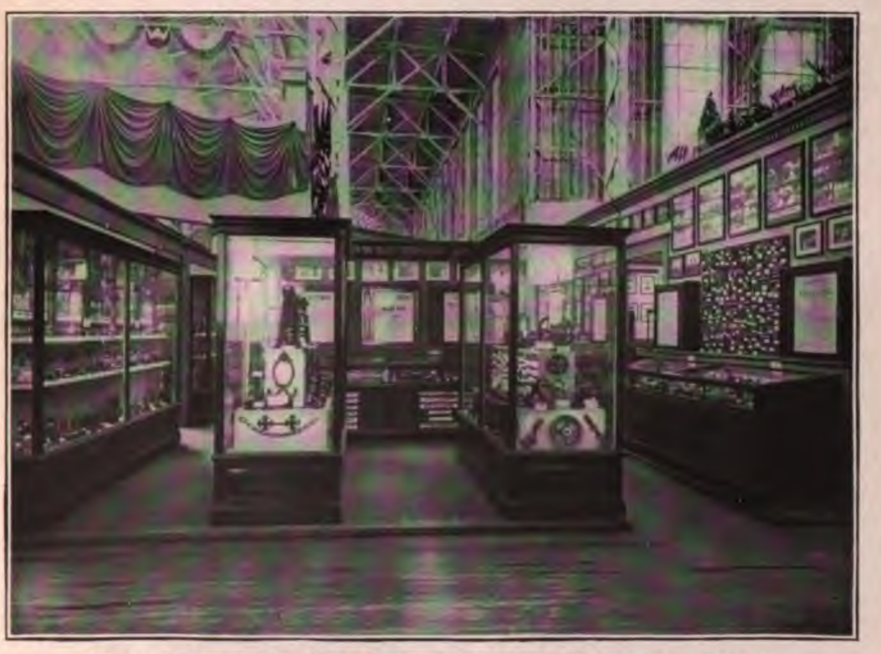


FIG. 2.—DRAWING AND SHOP PRACTICE, INCLUDING TEXTILES AND TRADES.

## MECHANIC ARTS EXHIBITS.

### CIVIL ENGINEERING.

This exhibit included publications, photographs, drawings, surveys, implements and apparatus, text-books, models of irrigation structures, etc., and specimens of students' work, illustrating the equipment, courses of instruction, methods of testing apparatus, and some results of work in this subject at the land-grant colleges, especially the examination of building materials.

### MECHANICAL ENGINEERING.

This included publications, photographs, drawings, students' notebooks, machinery and apparatus, models, and specimens of students' work, illustrating the equipment and results of work in this subject at the land-grant colleges.

### ELECTRICAL ENGINEERING.

This exhibit illustrated by means of plans, models, text-books, outlines of methods of instruction, photographs, diagrams, etc., the equipment and facilities for work in electrical engineering in three of the land-grant colleges. A prominent feature of the exhibit was a fully equipped telephone exchange.

### MINING ENGINEERING.

This exhibit consisted of a series of large transparencies illustrating the equipment and some results of the work in this subject of a few of the land-grant colleges.

### TECHNICAL CHEMISTRY.

This exhibit consisted of contributions from Cornell University, showing by means of a very complete series of photographs the facilities at the disposal of the student for carrying on chemical work, by means of charts and diagrams the courses of study pursued, and by means of specimens the results of the work; from Ohio State University, consisting of photographs showing the plant and some diagrams illustrating the course of study, the subject of quantitative analysis being shown in some detail by means of samples of materials analyzed and an outline of the procedure employed; from Pennsylvania State College, consisting in an elaborate display of the products of students' work in organic research, technical inorganic preparation, and organic preparation, the method of teaching quantitative analysis being shown by an exhibit of the materials used in the work; from Massachusetts Institute of Technology, showing the object sought after, the method employed, and the results obtained in teaching the various subjects of applied chemistry.

There were shown in detail all the branches of technical chemistry, including chemical engineering. A large number of photographs and drawings further illustrated the method of carrying on the work. The illustrative material used in a number of lectures (taken as types) was displayed.

### ARCHITECTURE.

This exhibit showed by means of photographs, plans, lecture notes, text-books, and students' work the methods of teaching and some of the results obtained in the three architectural options, viz, general architecture, architectural engineering, and landscape architecture.

### DRAWING AND SHOP PRACTICE, INCLUDING TEXTILES AND TRADES.

(Pl. XLII, fig. 2.)

The exhibit in this subject contained a large amount of material contributed by many institutions. It included views of shops, a great variety of specimens of shop work (iron and wood), exercises and specimens of work in forging, methods of instruction and specimens of work in textiles and drawing, besides miscellaneous apparatus, machines, models, and specimens illustrating all important lines of work in this group at the land-grant colleges.

### DOMESTIC SCIENCE.

In this exhibit the equipment of the land-grant colleges for instruction in this subject, some results of the work, and the methods and courses of instruction in sewing, dressmaking, fancy work, cooking, canning and preserving, etc., were illustrated by means of photographs, charts, and specimens contributed by nine of these colleges.

## SUPPLEMENTARY EXHIBITS.

### STOCK AND PLANT BREEDING AND JUDGING.

The collective exhibit in the Palace of Education was effectively supplemented by an exhibit in Live Stock Congress Hall, which was known as "School of breeding, feeding, and judging of live stock, and of breeding of field crops." This exhibit was planned by a subcommittee of the exposition committee of the association (see p. 696) and was in immediate charge of Prof. J. H. Shepperd, of the North Dakota College and Station, who reports on it as follows:

> Work representing the agricultural college class room and practice exercises and the experimental methods used in plant and animal breeding was set forth during two sessions of two weeks each between the dates September 12

and 24 and October 3 and 15, 1904. The plan followed was to have 25 students from five different agricultural colleges present to act as a class for the instructors to use in demonstrating their methods of teaching live-stock judging, dressing and curing meats, judging grain, making gluten, sponge and baking trials with flour, and in grading and milling wheat.

Tardiness on the part of the exposition management in completing the building used for the work greatly interfered with the progress of the exercises during the first session. An abattoir and refrigerator rooms were provided and demonstrations were made in judging all of the market classes of live stock for the block. Students were given demonstrations in slaughtering, cutting, and curing meats under the inspection of interested World's Fair visitors. Exercises in judging corn and small grain, and in placing rings of all the market and breeding classes of cattle, sheep, and swine constituted the programmes rendered from day to day. Evening sessions as well as forenoon and afternoon exercises were held daily. Moving pictures representing the active work of students in judging live stock, studying farm mechanics, judging corn, carrying out agricultural engineering class exercises, and the work of plant and animal breeding constituted a portion of the evening programmes. Addresses upon various phases of plant and animal breeding and the methods of instruction followed in kindred subjects filled the remaining available time during the four weeks that the exercises were carried on.

The attendance ranged from 50 to 1,000 people at a session, varying with the attendance at the fair and with the condition of the weather. The men who were in attendance at the live-stock show as exhibitors, jurors, and in other capacities were deeply interested in the programme and followed the detail of it closely.

An arena 40 by 70 feet was arranged in elliptical form in Live Stock Congress Hall and was surrounded by terraced seats sufficient to accommodate 1,100 people. One-half of this pavilion was set apart for demonstrations in plant-breeding work. Matured plants of oats, wheat, barley, spelt, millet, flax, and young plants of corn were set in natural form with interspaces about two-thirds as great as they usually occupy in plant nurseries. They were shown in all stages, some with clipped borders, others partially culled out in selecting the better plants, and others with the final or choice seed plants alone remaining. In other plats the plants were harvested and placed in their receptacles. Specimen record books were on exhibition and the forms of plant pedigrees which are kept were displayed to the public. All forms of plant records and labels used in experimental work were in their natural position, so that visitors were able to see an entire system which has been found practicable by investigators. Ripe bundles of grain were exhibited as they are placed in the field at harvest time and a thrashing machine for plant-breeding work was also on exhibition. A nursery fanning mill, an electric bake oven, and a small patent roller test mill were all exhibited in active operation. Nitrogen and fat extractors used in corn-breeding work were features of the display. The plant-breeding exhibit proved very suitable for exposition work. In that display a crowd was able to obtain a good general idea of the work in a few minutes, and those who chose to spend a longer time were not discommoded by the ones who made a less complete study of the exhibit.

The stock-judging exercises by students and the demonstration of methods used in stock-judging instruction by teachers attracted favorable attention and large crowds, while the small grain and corn judging work was well received.

The slaughtering and cooking trials proved especially attractive to the stock breeders and exhibitors present, who followed the trials closely and took a deep interest in them. Many of the exhibitors maintained that the experiment stations are the only interested parties who can successfully carry out slaughtering trials with live stock, as exhibitors do not like to furnish animals which have ranked well on foot and have them fall behind when the crucial test of slaughtering is resorted to.

Sixty-two students from 11 institutions constituted the classes during the two sessions.

The indications are that the school made a marked impression upon a considerable body of people (estimated at 30,000), who gained through it a much clearer conception of the methods employed at the agricultural colleges and experiment stations than they had previously had or than could well have been given in any other way.

### Publications Relating to the Exhibit.

Special pamphlets describing the exhibit and explaining the system of agricultural education and research in the United States there represented were prepared in the Office of Experiment Stations and freely distributed in connection with the exhibit.

### Awards to the Exhibit.

The following is a list of the awards granted to institutions and individuals on their contributions to the exhibit:

#### GENERAL AND AGRICULTURAL EXHIBITS.

*Grand prizes.*—(1) Association of American Agricultural Colleges and Experiment Stations, collective exhibit of the colleges and stations, made by the committee of the association; (2) section of agronomy, in charge of J. I. Schulte, collective exhibit showing courses of instruction and methods and results of investigations on field crops; (3) section of horticulture and forestry, in charge of S. B. Green, collective exhibit illustrating courses of instruction and methods and results of investigation in horticulture and forestry; (4) section of economic entomology, in charge of C. P. Gillette, collective exhibit illustrating courses of study in entomology, and collection of economic insects; (5) dairy laboratory, in charge of E. H. Farrington; (6) sugar laboratory, in charge of W. C. Stubbs; (7) plant laboratory, in charge of W. H. Evans; (8) Alabama Station, exhibit showing cotton experiments; (9) Connecticut State Station, tobacco exhibit, tent model illustrating the culture of tobacco under shade, and grass garden exhibit, by E. H. Jenkins; (10) Illinois Station, corn-breeding experiments, by C. G. Hopkins; (11) Louisiana Station, exhibit illustrating cane-sugar investigation; (12) Minnesota Station, wheat-breeding exhibit, by W. M. Hays; (13) Missouri Station, models representing the results of experiments in cattle feeding; (14) Missouri University, models showing comparative hardiness and phenology of peach twigs of different colors, and winter forcing of asparagus in the open field; (15) University of Missouri, cultures of mushrooms and other fungi, by B. M. Duggar; (16) Pennsylvania Station, working model of respiration calorimeter for domestic animals; (17) University of Wisconsin, dairy instruction and results of investigation; (18) S. M. Babcock, of Wisconsin, the original Babcock milk tester; (19) Office of Experiment Stations, statistics, charts, and publications relating to the American stations and the Office of Experiment Stations; (20) Bureau of Education, charts and publications.

*Gold medals.*—(1) Section of animal husbandry—investigation, in charge of H. P. Armsby; (2) section of animal husbandry—instruction, in charge of Thomas F. Hunt; (3) section of fertilizers, in charge of E. B. Voorhees; (4) section of plant pathology, in charge of F. C. Stewart; (5) section of rural engineering, in charge of Elwood Mead; (6) section of veterinary medicine, in charge of D. S. White; (7) soils laboratory, in charge of M. F. Miller; (8) Arizona Station, collection of date palms and date-palm products, by R. H. Forbes; (9) B. C. Buffum, of Wyoming, automatic water register; (10) California University, soil samples and investigations, by E. W. Hilgard; (11) Connecticut State Station, collection of pure vegetable proteids; (12) Connecticut Storrs Station, cultures of milk bacteria, by H. W. Conn; (13) Cornell University, exhibit of root crops; (14) Cornell University, apparatus for photographing cultures of bacteria and fungi, by G. F. Atkinson; (15) University of Illinois, photographs and records showing relative efficiency of dairy cows, by W. J. Fraser; (16) Maine Station, study of comparative value of hens for egg production; (17) Michigan Agricultural College, models of fruits, collection of photographs and models illustrating work and results of horticulture and forestry; (18) University of Minnesota, model greenhouse laboratory bench, and forestry exhibit; (19) Missouri Station, breeding cage, photographs of laboratories and equipment for work in economic entomology, and collection of beneficial insects; (20) New Jersey Stations, typical soils and fertilizers; (21) New York State Station, charts and graphic representations of investigations on sources of milk fat; (22) New York State Station, charts showing effect of temperature in curing and paraffining cheese, and losses in manufacture, by L. L. Van Slyke; (23) New York State Station,[a] exhibit showing correlation between specific gravity of seed and germinating power and vigor of resulting plant, models of grapes and grape pollen showing correlation between character of pollen and self-fertility of the variety; (24) New York State Station, collection of commercial feeding stuffs, illustrating inspection work; (25) North Dakota Station, exhibit of flax breeding and of root systems; (26) Ohio State University, collection of normal and diseased bones from horses and oxen illustrating more common diseases and fractures; (27) Purdue University, apparatus for recording the growth of plants, by J. C. Arthur; (28) Tennessee Station, apparatus and investigations on effect of fungicides on foliage, by S. M. Bain; (29) Texas Agricultural College, cages for breeding insects, the boll weevil and its injuries, and card system of keeping notes and records; (30) Utah Agricultural College, exhibit of work in domestic science; (31) Virginia Station, pure cultures for use in fermentation industries, by W. B. Alwood; (32) Washington Station, results of wheat breeding, illustrating Mendel's law.

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[a] This award subsequently raised to grand prize.

*Silver medals.*—(1) Section of biological sciences, in charge of G. E. Stone, collection illustrating work in biological sciences at the land-grant institutions; (2) section of inspection work, in charge of M. A. Scovell, collection illustrating inspection work of the stations; (3) Arkansas Station, exhibit showing experimental work with cowpeas; (4) Connecticut State Station, wood engravings showing the microscopic structure of cattle feeds; (5) Hampton Normal and Agricultural Institute, courses of instruction and samples of student work; (6) Hawaii Station, collection of fruits illustrating improvements; (7) Kansas Agricultural College, exhibit of cereals and forage crops and root systems of plants; (8) Kansas Agricultural College, collection of woods for post purposes, illustrating rate of growth; (9) Kentucky Station, exhibit of hemp; (10) Maine Station, freezing microtome, by W. M. Munson; (11) Maine Station, crossing and improvement of types of tomatoes and blueberries; (12) Michigan Agricultural College, materials showing instruction in domestic science; (13) University of Minnesota, courses of instruction in domestic science and sewing; (14) University of Missouri, influence of birth weight of animals on subsequent growth; (15) New Jersey Station, results of experiments on forage crops for dairy cows; (16) New Mexico Station, photographs and charts showing benefits from arsenical sprays for codling moth, and the number of broods; (17) Cornell University, poultry breeding for egg production, and trap nests; (18) North Carolina Station, specimens and charts illustrating feeding value of cotton-seed products; (19) Ohio State University, apparatus for instruction in soils; (20) Rhode Island Station, photographs illustrating life habits of the apple maggot; (21) Utah Station, model of irrigation farm and model vegetation house; (22) Utah Station, centrifugal apparatus for mechanical analysis of soils; (23) Vermont Station, charts illustrating composition and comparative value of silage and analyses of butter produced on different rations; (24) Vermont Station, maple-sugar making; (25) University of Wisconsin, soil aspirator and apparatus for determining relative rates of flow of air through soils of different texture and structure; (26) Wisconsin University, instruction and investigation in drainage and irrigation; (27) Wisconsin Station, feeding value of corn by-products.

*Bronze medals.*—(1) Section of home economics, in charge of Maude Gilchrist, collective exhibit illustrating courses of instruction in home economics, with samples of students' work; (2) section of rural economy, in charge of F. W. Card, collection illustrating courses of study in rural economics; (3) Clemson Agricultural College, exhibit of evaporated sweet potatoes; (4) Connecticut State Station, specimens of plant diseases; (5) Connecticut Storrs Station, effect of cleanliness of milking, by W. A. Stocking, jr.; (6) L. C. Corbett, apparatus for measuring transpiration from growing plants; (7) Cornell University, colored lantern slides of insects, and block system for pinning insects in collections; (8) Florida Station, exhibit of velvet beans; (9) Hawaii Station, injurious insects of Hawaii; (10) University of Illinois, effect of clean and unclean udders on the cleanliness of milk; (11) Iowa State College, effect of various fermentations on milk, by G. L. McKay and F. W. Bouska; (12) Kansas Agricultural College, photographs of canned goods, laboratories, and specimens of work; (13) Kentucky Station, collection illustrating food and fertilizer inspection work; (14) Louisiana Station, exhibit of sugar cane and rice; (15) Maine Station, colored illustrations showing apple maggot and its work; (16) Massachusetts Station, exhibit of soy beans and Japanese millets; (17) Michigan Agricultural College, models of forest nurseries for conifers; (18) University of Minnesota, methods of instruction in veterinary science; (19) Missouri Station, wood-destroying fungi and specimens of plant diseases; (20) University of Nebraska, models of homemade windmills, by E. H. Barbour; (21) New York State Station, investigations on rusty spot in cheese, by H. A. Harding; (22) New York State Station, wax models showing San José scale upon fruit, bark, and foliage; (23) Office of Experiment Stations, charts showing experiments on horse feeding, with sample rations; (24) Ohio State University, models and photographs illustrating subirrigation in greenhouse, garden, and lawn; (25) Ohio State University, specimen of cow, showing dissection work, with retention of organs in normal position, by S. Sisson; (26) Oregon Agricultural College, exhibits of hops and of flax; (27) Pennsylvania Station, preparations of pentosans from timothy hay; (28) Purdue University, apparatus for illustrating effect of gravity on growing plants, by J. C. Arthur; (29) Purdue University, students' farm plans; (30) A. H. Standish estate, instruments for measuring live stock; (31) University of Wisconsin, materials showing methods of pruning; (32) University of Wyoming, models of Cipolletti weir, rating flume, and Foote water meter.

### MECHANIC ARTS EXHIBITS.

The juries of groups 3 and 6 made the following awards in mechanic arts:

*Grand prizes.*—Section of mining engineering, in charge of S. B. Christy, collective exhibit illustrating facilities for instruction in mining engineering; section of architecture, in charge of W. H. Lawrence, collective exhibit illustrating courses of instruction in architectural subjects, with samples of student work; section of mechanical engineering, in charge of W. F. M. Goss, collective exhibit illustrating courses of study in mechanical engineering, with samples of student work and tested materials; section of technical chemistry, in charge of W. H. Walker, collective exhibit illustrating methods of instruction in chemical analysis, with materials analyzed by students; section of drawing and shop practice, in charge of F. P. Anderson; College of Mining, University of California, facilities for instruction in mining engineering.

*Gold medal.*—Massachusetts Institute of Technology, mining engineering; Mississippi Agricultural College, drawing and shop practice; New Mexico Agricultural College, ditto; Clemson College, ditto; Hampton Normal and Agricultural Institute, ditto; F. Paul Anderson, collaborator.

*Silver medals.*—Massachusetts Institute of Technology, exhibits in technical chemistry and of drawing (3); Nevada State University, mining; Cornell University, architecture; Sibley College, Cornell University, mechanical engineering; Pennsylvania State College, technical chemistry (2).

*Bronze medals.*—Massachusetts Institute of Technology, mining; University of Tennessee, mechanical engineering; Clemson College, mechanical engineering (?).

### CONCLUSION.

The list of awards indicates that in the minds of the juries of awards the exhibit merited generous recognition, and the general comments upon it were, as a rule, of the most favorable character.

In its preliminary report on the exhibit the exposition committee of the Association of Colleges and Stations says:

> It was not a "show" exhibit. Mere beauty or novelty of display was not the main object sought. While every reasonable effort was put forth to make it attractive in its design, arrangement, and coloring, the materials which were selected for display were those which are in actual use for the purposes of instruction in the various departments of our land-grant colleges, or those which represent, with as much realism as possible, the actual practical results of research. We are glad to have been assured that the exhibit was found profitable for study on the part of the real seekers after information, and that it impressed itself upon intelligent observers as a worthy and consistent exposition of certain features of education and research in the relations of science to agriculture and the mechanic arts.

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